THE ILLUMINATING ENGINEER

THE JOURNAL OF GOOD LIGHTING

LIGHT
LAMPS
FITTINGS
AND
ILLUMINATION

OFFICIAL ORGAN of
The Illuminating Engineering Society
(Founded in London, 1909; Incorporated 1930)
and of
THE ASSOCIATION OF PUBLIC LIGHTING ENGINEERS
(Founded 1923; Incorporated 1928)

OIL
GAS
ELECTRICITY
ACETYLENE
PETROL-AIR
GAS
ETC.

Vol. XXIV | July, 1931 | Price NINEPENCE
Subscription 10/6 per annum, post free
For Foreign Countries, 15/- per annum

Special Features:

The chief items in this issue are the series of Reports issued by the Illuminating Engineering Society, viz. :—(1) The Annual Report of the Council. (2) Reports of Sub-Committees on the Natural and Artificial Lighting of Schools and the Artificial Lighting of Libraries. Other items include Evaluation of Glare in Street Lighting Installations — Modelling in Light — Lighting Literature, etc.

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Edited by
J. STEWART DOW

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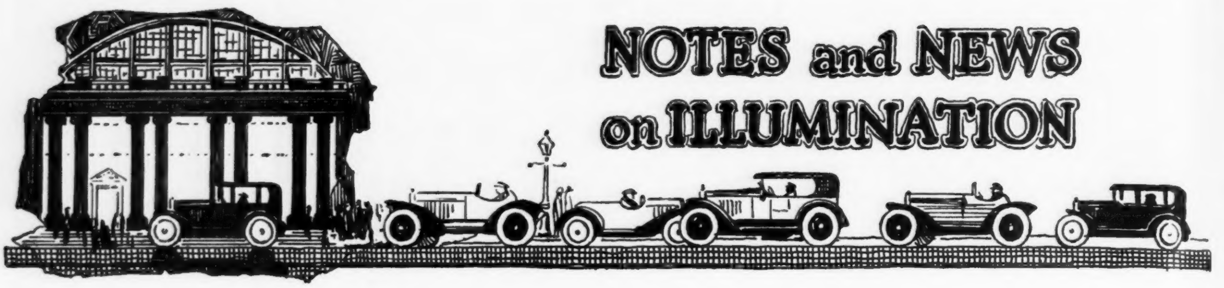
The Illuminating Engineering Society—A Year's Progress

IN this number we present (pages 151-4) the customary Report of the Council for the past session. We think that it will be generally agreed that the Society has done well and has every reason to be satisfied with this record of progress. Papers and discussions have been quite as varied and interesting as in past years, and the attendance at meetings seems to be continually growing. Many members of the Society also perform useful service in other fields; for example, on the numerous committees of the Department of Scientific and Industrial Research, the National Illumination Committee, and the British Engineering Standards Association. In addition the newly formed Technical Committee of the Illuminating Engineering Society has undoubtedly "made good." Through its subcommittees it has already delivered reports on the natural and artificial lighting of schools and on the artificial lighting of libraries. It has made itself responsible for the review of progress presented at the opening of each session, and has initiated the section entitled "Literature on Lighting," which has proved an acceptable feature in this journal. Two other important pieces of constructive work have been carried through—the incorporation of the Society and the completion of arrangements for the administration of the Gaster Memorial Fund. Finally, even bearing in mind the fact that the Society will this year be faced by exceptional expenditure (such as its contribution to the funds of the International Illumination Congress), the financial position has improved very materially, and is already much stronger than it was a few years ago.

All this is gratifying, but it would be a bad thing to be content with what *is* and cease to press on towards yet greater advances. The end of a session should be a time to take stock; not only to record successes, but to search for possible weaknesses that need to be made good. To our mind there are several directions in which the Society has, as yet, achieved only partial success. During the past session papers read became for the first time eligible for the grant of the Gaster Memorial Premium, awarded annually for the best contribution to the Society. It is our hope that this memorial to the founder of the Society will lead to the presentation of papers of outstanding merit and original character, such as will add to the prestige of the Society. The papers read during the recent years, whilst varied in scope and frequently admirable in matter, have hardly been sufficiently distinctive in the sense of communicating results of important research or revealing marked originality of treatment. What we do need for the Illuminating Engineering Society is papers containing information that cannot be obtained elsewhere, so that the Society may come to be regarded, not only as an excellent medium for the discussion of familiar data, but as an originating force, continually giving birth to new ideas.

The second instance of only partial success is to be found in the membership of the Society. This, it is true, shows steady growth. But it does not advance nearly as rapidly as one could desire and might reasonably expect. For we consider the Society has a magnificent field of its own, the study of all applications of light in the service of mankind, in which literally everyone is interested in some degree. It has wisely determined to organize its membership on liberal lines, admitting not only experts, but users of light, so that by their interchange of thought practical solutions of lighting problems may be attained. Whilst the Society, as remarked above, does not seem to have yet become a sufficiently powerful originating force, it does admittedly fulfil admirably the purpose of making existing principles and information known. Yet even in this respect it cannot effect its purpose perfectly unless it has a much wider circle of influence. At present its activities are confined almost exclusively to London. The desirability of forming local sections has already been discussed and some preliminary work in this direction has been done.

There is reason to believe that the tour of the International Illumination Congress throughout a number of the chief cities in England and Scotland will have an important influence in kindling local interest in illumination and may pave the way for a subsequent effort to bring this movement to form local branches to a successful issue. This task of widening the existing membership should enlist the active participation of members as a whole. One of the most potent means of drawing members together and attaching them firmly to their Society is to ask service of them—to make them feel that the prosperity of the Society depends on their personal efforts as well as the work of the officers and council. We invite constructive suggestions as to how the influence of the Society can be thus consolidated and extended.



Automatic Control of Public Lighting in Glasgow

We notice that *The Evening Citizen* has been foreshadowing the ultimate passing away of the "leerie," whose services in lighting public lamps were immortalized by Robert Louis Stevenson. As is well known, Mr. S. B. Langlands, the Inspector of Public Lighting in Glasgow, has been experimenting for some time with automatic control by selenium "bridges," which turn on the lights automatically when daylight fails and extinguish them at dawn. As some hundreds, or even thousands of lights may be controlled by a single mechanism of this kind, the apparent menace to the "leerie" is evident, though as a rule other openings for the services of displaced lamplighters are readily found. In Glasgow control of public lamps is doubtless a specially acute problem. No less than 630 miles of streets, requiring about 40,000 lamps, have to be lighted, while the increase during the last five years has been at the rate of 20 per cent. per annum. In addition there are the stair-lights, peculiar to Glasgow, which number about 90,000. We learn from *The Evening Citizen* a new fact—and one greatly to the credit of Glasgow—"whilst other cities in Scotland and England were content that their street lighting should be looked after by the City Engineer, the Gas Manager, the Electricity Manager, the Burgh Surveyor or even the Chief Constable, Glasgow set up, nearly a century ago, its Inspector of Lighting."

Illuminating Engineering in Japan

The contents of the April issue of the Journal of the Illuminating Engineering Society of Japan are of a varied character. We notice a paper by N. Kadokura and S. Nakajima reviewing the theory of photo-electric cells. There are also extracts from a pamphlet issued by the Tisiki Hukyu Iinkwai (Committee on Promoting Knowledge of Illumination) which is embellished by attractive photographs of lighting installations and is described as "a handy guide book on well-lighted places." The revised American code on Nomenclature and Photometric Standards is reproduced (English terms and explanations in Japanese characters being curiously interlinked). A feature is the attention devoted to abstracts from current literature on lighting, titles and names of authors being presented in the language of the country of origin. We notice that papers by Mr. J. A. Mackintyre and H. N. Green read before the Illuminating Engineering Society in this country have been abstracted.

One of the World's Brightest Shops

This is the description applied to Seton's Store, Buffalo, by Mr. J. W. Fleming in *The Magazine of Light*. The interior of the store receives indirect lighting—yet the illumination is stated to be 50 foot-candles. The consumption is approximately 16.5 watts per square foot. The window-lighting, of which a picture is given in the original article, is on a similar impressive scale. An illuminated overhead canopy covering the passage between side-windows utilizes 7 kw., and the windows receive over 400 watts per foot run. The total connected load is more than 40 kw., which is believed to be the heaviest commercial lighting load for its area ever installed by the Niagara Hudson Power System. The President of the firm has expressed his satisfaction with the results. He was told that the absence of lighting fixtures would make the store look larger and that the high illumination would "cut down sales resistance." From all accounts this prediction has been verified. Mr. Seton, the President, also remarked: "As advertising alone I consider my lighting—interior, window and exterior—far greater than any other medium at twice the price!"

Street Lighting in Oldham

The annual report of the Superintendent of Public Lighting in Oldham (Mr. I. H. Massey) is, in the main, a record of progress in detail. Improved lighting fittings have been introduced in a considerable number of streets, and additional lights furnished at specially busy places. Some statistics for the years 1924-1930 are presented. During this period there seems to have been a tendency to change over to electric lighting, at least so far as consumption is concerned; the gas consumed having diminished from 110,738,000 cub. ft. in 1924 to 72,023,000 in 1930, whereas the number of units of electricity used has risen from 562,984 to 808,601 during the same period. At the present time, however, there are still over 4,000 gas lamps in use, including 421 high-power low-pressure lamps and 72 high-pressure (1,500 candle-power) lights, as compared with 936 electric lamps (including 10 of 1,000 watts). The high-pressure gas lighting in the Huddersfield Road and the low-pressure lighting in Lees Road are mentioned as having met with special approval.

A Large Illuminated Sign

In *Illumintotecnica* there is a description of an unusually large and effective illuminated sign, prepared by La Compagnie des Chemins de Fer du Nord, to advertise the express service from Paris to Liege during the recent exhibition in the latter city. The sign comprises a highly animated locomotive, with a legend below announcing the journey of 377 km. without a stop. Incandescent lamps and neon tubes both contribute to the general effect, the border involving 140 metres of blue neon tubing. The motions of the engine and the smoke from its funnel appear to have been simulated with considerable ingenuity, and the mechanism is described in detail. The technical aspect of the sign is interesting, but to our mind what is even more impressive is the enterprise of the railway company responsible. Let our British railways take notice!

TECHNICAL SECTION

COMPRISING

Transactions of The Illuminating Engineering Society and Special Articles

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

Report of the Council for the Session October, 1930, to June, 1931

(Presented at the Annual General Meeting of the Illuminating Engineering Society, held in the Lecture Theatre of the E.L.M.A. Lighting Service Bureau, 15, Savoy Street, Strand, London, W.C.2, at 6 p.m., on Tuesday, May 19th, 1931.)

ALTHOUGH conditions during the past session have been in some respects more difficult than in the preceding one, the Council is again able to report progress in the work of the Society. The valuable aid received by the Council from members in their effort to place the Society on a firm foundation has led to a further strengthening of its position.

Election of Officers and Council for the Next Session.

The procedure in regard to the election of Officers and Members of Council, which is now determined by the Articles and By-laws of the Society, has been the same as that adopted during the previous session. The nominations made by the Council to fill vacancies have been published in *The Illuminating Engineer** and circulated to all members, who were thus afforded an opportunity of making additional nominations if they so desired. One independent nomination, in support of Capt. W. J. Liberty, has been received and added to the Council's nomination. These gentlemen are now automatically elected. Accordingly Sir Francis Goodenough, C.B.E., will become President for the next session; Mr. H. Hepworth Thompson will become Vice-President; Mr. J. S. Dow and Mr. J. Wyatt Ife will continue as Hon. Secretary and Hon. Treasurer respectively.

The following members will fill vacancies on the Council: Mr. J. Eck, Mr. S. B. Langlands, Capt. W. J. Liberty, Mr. Howard Robertson, Mr. W. Millner, Mr. J. C. Walker and Mr. H. C. Wheat.

Incorporation of the Society.

The task of the Committee charged with the duty of preparing the Memorandum, Articles and By-laws of the Society for presentation to the Board of Trade was completed during the past session. These documents have been finally approved by the Authorities, and the Society was duly registered as an incorporated body on November 24th, 1930. In accordance with the Articles, a General Meeting was held on January 12th, 1931, when the incorporation was announced, and the Memorandum, Articles and By-laws, now available in printed form, were formally presented. The fact of the Society becoming an incorporated body should add to its prestige. The Council desires to record its appreciation of the services of the members of the Committee, whose somewhat onerous labours have been carried to this successful conclusion.

* March, 1931, p. 52.

Work of Committees.

The work undertaken by the Committees of the Society tends each year to become more extensive and important. It may be recalled that the existing committees were reviewed during the session 1929-1930. The two *ad hoc* committees then sitting, concerned (1) with the Articles of Association and Incorporation and (2) with the Leon Gaster Memorial Fund, have now completed their labours, and are therefore automatically dissolved. There remain the three standing administrative committees, namely, the General Purposes Committee, the Papers Committee and the Technical Committee, which are elected annually.

These three committees were constituted as follows:—

General Purposes Committee: Lt.-Col. Kenelm Edgcumbe (President), Mr. J. S. Dow (Hon. Secretary), Mr. J. Wyatt Ife (Hon. Treasurer), Mr. L. E. Buckell (*Chairman*), Mr. F. W. Purse, and Mr. H. Hepworth Thompson.

Papers Committee: Mr. A. Cunnington (*Chairman*), Dr. S. English, Mr. W. J. Jones, Mr. John Terrace and Dr. W. J. T. Walsh.

Technical Committee: Mr. A. W. Beuttell (*Chairman*), Mr. A. Blok, Mr. H. Buckley, Mr. J. S. Dow, Dr. S. English, Mr. Hadyn T. Harrison, Mr. W. J. Jones, Mr. E. L. Oughton, Mr. Howard Robertson, and Mr. G. H. Wilson.

(The President and Hon. Secretary are ex-officio members of all committees, but do not necessarily preside over committees at which they are present in their official capacities.)

The Technical Committee has continued to justify its existence by initiating useful work. The sub-committees on School Lighting and Library Lighting, entrusted with the task of revising the reports on these subjects, issued by joint committees of the Society prior to the war, have made considerable progress. An interim report to the Council was presented by the School Lighting Committee, which hopes shortly to be able to present a revised version of the original report on school lighting. The sub-committee on Library Lighting has already completed its task. The revised report prepared by them has been accepted by the Council of the Illuminating Engineering Society and by the Library

Association, and will, it is hoped, be published very shortly in the journal of the Society.

Sub-committees have also been formed to deal with such matters as research, education, and the lighting of mines. Amongst other steps initiated by the Technical Committee may be mentioned (1) the appointment of correspondents, who will act as links with various kindred bodies of a scientific or technical character; and (2) the publication in the journal of a new section, "Literature on Lighting," consisting of abstracts of the chief articles bearing on illumination and photometry that have appeared in the technical press during the preceding month. The task of supervising the preparation of these abstracts is shared by various members of the Technical Committee.

Finally, it may be recalled that the Technical Committee was entrusted for the first time with the preparation of the Report on Progress read at the opening meeting of the present session. Whilst it is hoped to make this report even more complete in the future, it is felt that the report presented in October, 1930, represented a distinct advance on that evolved in previous years.

The Leon Gaster Memorial Fund.

The work of the Committee concerned with the Leon Gaster Memorial Fund has now been successfully concluded. The conditions relating to the administration of the fund have been embodied in a trust deed, and the Council desire to express their appreciation of the services of Messrs. Guscotte, Fowler & Cox, who, in an honorary capacity, undertook the preparation of this deed and advised the Council on legal aspects. Mr. A. Blok and Dr. J. W. T. Walsh kindly consented to act as trustees in the initial stages of the formation of the fund until the Society, having become an incorporated body, became itself competent to act as trustee.

From the account presented in the Appendix it will be noted that the fund now consists of £230 invested in 5 per cent. War Loan, together with the sum of £30 5s., which is at present placed on deposit, but may be in part required to meet the cost of preparing certificates.

As mentioned in the last report of the Council, the interest on this fund is to be applied to the annual award of a Leon Gaster Premium for the best contribution on any aspect of illuminating engineering submitted to the Society during the year, which will be accompanied by an inscription on vellum recording the award. Papers presented before the Society during the session just terminated will be eligible for this award.

Meetings of the Society.

The programme of papers was again of a varied character. The opening meeting, on October 8th, was, as usual, devoted to a report on progress, which was supplemented by a series of exhibits illustrating recent developments in illuminating engineering. As mentioned above, the preparation of the report was undertaken by a panel of reporters, formed by the Technical Committee. The aim has been to select, so far as possible, reporters having special knowledge of the aspect of lighting confided to them; as these reporters in turn approach other members of the Society for information, it is evident that the report becomes a joint effort in which many members share, and which should become more complete year by year as the machinery for the collection of information is improved.

The second ordinary meeting, on November 14th, 1930, was devoted to a paper by Mr. J. A. Mackintyre on "The Lighting of Offices and Public Buildings." The paper, which reviewed both natural and artificial lighting, gave rise to an interesting discussion. On December 12th, 1930, Dr. S. English was responsible for a paper entitled "Glass for Use with Invisible (Ultra-Violet and Infra-Red) Rays," which was illustrated by numerous attractive experiments.

The paper read at the next meeting, on January 12th, by E. L. Oughton, was also well illustrated. The author, in reviewing "Recent Developments in Gas Lighting," exhibited modern types of fittings which proved of considerable interest to many of those present. The discussion on "Problems in Illuminating Engineering," which took place on Feb. 18th, proved once more a popular feature. The opening contribution, by Mr. T. F. H. Marsh, dealt with the problem of "Testing the Relation between Intensity of Illumination and Visual Capacity." Mr. J. H. Parker (Electrical Engineer, L.C.C. Tramways) gave an illustrated description of "The Lighting of the New Kingsway Tunnel," and Mr. Oliver P. Bernard gave a summary of the ideas underlying "The Use of Coloured Light at the International Exhibition of Persian Art." Other interesting items included "The Illumination of Furniture" (Mr. H. H. Long), "The Floodlighting of the Singer Machine Co.'s Building" (Mr. R. A. Ives), and "The Lighting of a Large Warehouse" (Mr. G. W. Golds).

Mr. H. T. Young's paper on "Modern Domestic Lighting," presented on March 19th, was noteworthy for the effective methods of illustrating decorative lighting adopted by the author, whose ideas gave rise to an interesting discussion. It is believed that the attendance at this meeting, which was held in the lecture theatre of the Institution of Electrical Engineers, was a record in the annals of the Society. The final paper, by Mr. W. Grant Mackenzie, on April 21st ("Some Aspects of Street Lighting in the United States") was made the occasion of a general invitation to all members of the Association of Public Lighting Engineers, a number of whom took part in the discussion.

In addition to these monthly meetings two visits were arranged, to Messrs. Gamages (West End) Ltd., on November 18th, and to the L.G.O. Repair Works at Chiswick, on December 12th, 1930. About 50 members and friends took part in each of these visits, and on each occasion much of interest was seen.

Meetings in Provincial Centres.

A special meeting was arranged in Manchester on October 22nd, 1930, when an address on "Illuminating Engineering: "What It Is, and What It May Become" was given by Mr. J. S. Dow. The meeting was well attended and gave rise to a good discussion, in the course of which a resolution in favour of the formation of a local section in the North-Western Area was passed. As indicated in previous reports, the Council is hopeful that ultimately local centres in several areas will be formed, and the conditions under which such centres can with advantage be formed have been the subject of much study by the General Purposes Committee. It is evident that a necessary preliminary in all such cases is for an adequate nucleus of local members to be formed, and it is to be hoped that existing members in provincial cities will aid the Council in realizing this condition as speedily as possible.

The Annual Dinner.

The annual dinner, which took place at the Trocadero Restaurant, Piccadilly Circus, on February 10th, was generally considered to be one of the most successful yet held by the Society. The attendance as shown by the table plans, 195, was a record

The Illuminating Engineering Society

32, VICTORIA STREET, LONDON, S.W.1

Dr. INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31st DECEMBER, 1930. *Cr.*

EXPENDITURE.

	£ s. d.	£ s. d.
To Administration Expenses		
Rent, etc.	150 0 0	
Printing	78 17 0	
Duplicating	21 11 3	
Postage and Petty Cash	43 6 1	
Hire of Halls for Meetings ...	25 9 0	
Reports and Lantern Operators...	21 12 6	
Refreshments at Meetings... ...	20 0 6	
Hire of 'Buses	2 10 0	
Bank Charges	0 16 0	
		364 2 4
,, Provincial Meetings Expenses		
Hire of Halls...	5 12 4	
Printing, Reporting and Lantern Operator	6 18 0	
Travelling Expenses, etc.	5 1 3	
		17 11 7
,, Annual Dinner	106 14 0	
Less Receipts...	101 0 0	
		5 14 0
,, Illuminating Engineering Publishing Co., Ltd., Share of Subscriptions		278 12 0
,, National Illumination Committee		32 0 0
,, Incorporation Expenses		164 10 4
,, Excess Income over Expenditure for the Year		95 9 0
		£957 19 3

INCOME.

	£ s. d.
By Subscriptions	930 7 9
,, ,, outstanding, estimated	20 0 0
,, Interest on Deposit	7 11 6
	£957 19 3

BALANCE SHEET, 31st DECEMBER, 1930.

	£ s. d.	£ s. d.
Creditors		164 16 2
Subscriptions paid in advance		16 16 0
Capital Account		
Balance from last Account... ...	530 0 10	
Add Excess Income over Expenditure for the Year	95 9 0	
		625 9 10
		£807 2 0

	£ s. d.
Cash at Bank	
Current Account	86 12 10
Deposit	700 0 0
Cash in Hand	0 9 2
Subscriptions outstanding, estimated ...	20 0 0
	£807 2 0

LEON GASTER MEMORIAL FUND ACCOUNT, 31st DECEMBER, 1930.

	£ s. d.
Subscriptions Received as last Account	214 10 0
Further Subscriptions during the Year	51 10 0
Interest on Deposit	0 18 2
	£266 18 2

	£ s. d.
Invested in £230 War Loan	236 13 2
Cash on Deposit	30 5 0
	£266 18 2

We have examined the above accounts with books and vouchers, and certify same to be correct in accordance therewith, and that the Balance Sheet exhibits a true and correct view of the Society's affairs according to the information and explanations given to us.

Dated this 8th day of April, 1931.

ROBERT J. WARD & Co., *Chartered Accountants,*
10, Serjeant's Inn,
Fleet Street, London, E.C. 4.

—even the number present at the twentieth anniversary dinner in 1929 being exceeded. The toast of "The Illuminating Engineering Society" was proposed by Sir John Brook (Deputy Chairman of the Electricity Commission). The President, in responding, recalled that it was just 22 years since the original dinner at which the Society was founded. The toast of "The Guests" was proposed by Dr. J. W. T. Walsh, and was coupled with the names of Sir Joseph Petavel (Director of the National Physical Laboratory), and Mr. H. V. Ashley (Vice-President of the Royal Institute of British Architects), both of whom alluded to the useful work that the Society was doing, and conveyed wishes for a prosperous future. The method adopted during recent years of keeping the toast list within modest limits and thus allowing time for social intercourse during the latter part of the evening, evidently met with the approval of the guests. An interesting event was the "guessing competition" in regard to the illumination on the dinner table; the winning guess was near to the actual value (5.87 foot-candles), but individual estimates covered a very wide range.

Increase in Membership.

The Council is again able to record a steady flow of new members. During the past session 36 Corporate Members and 21 "Country Members" have been added. This may be considered an encouraging addition, bearing in mind the prevailing industrial depression. Yet it falls far short of what is desired and might be expected, considering the continual growth of public interest in the topics with which the Society is concerned. This problem of securing increased membership is one which, it is felt, should receive increased attention from the Council and members during the coming session.

Financial Position.

The accounts for the past financial year, which are attached to this report, have been duly audited by Messrs. Robert J. Ward & Co., chartered accountants, who have kindly consented to act as Honorary Auditors of the Society. The Council desire to take this opportunity of thanking the Hon. Auditors for their valuable services, and also of putting on record their appreciation of the efficient manner in which the accounts have been kept by the Hon. Secretary and his staff.

It will be observed that the income of the Society shows an increase, as compared with the previous year, despite the fact that the Society, in common with others, has experienced increased difficulty in collecting subscriptions. The increase, moreover, would have been considerably greater had only the actual cash received (irrespective of the period in respect of which it was paid) been recorded. In spite of the fact that the whole of the heavy incorporation expenses have been debited to the past year, there is an excess of income over expenditure of £95 9s. Finally, it will be noted that the amount on deposit was raised from £400 to £700 during 1930. (Of this sum a portion has since been invested in £400 5 per cent. War Loan.)

The present position may therefore be considered very satisfactory, but it is well to remember that with the increasing activities of the Society its expenditure necessarily tends to increase, and that during the present year the Society has undertaken to make a substantial contribution to the expenditure involved in the International Illumination Congress. It is felt, therefore, that no opportunity should be lost of strengthening the present position.

The International Illumination Congress, 1931.

During the past year much effort has been expended in preparations for the forthcoming International Illumination Congress, which is to be held in this country during September 1st—19th, 1931. The President of the Congress (Mr. Clifford C. Paterson) is a Past President of this Society; the Chairman of its General Council (Lt.-Col. Kenelm Edgcumbe) is our present President; the Hon. Treasurer of the Congress (Sir Francis Goodenough) is our President-elect. Further, the Hon. General Secretary of the Congress (Col. C. H. S. Evans) has been serving on the Council for the past three years.

The Illuminating Engineering Society is thus very closely associated with the Congress, and the Council is confident that all members will do their utmost to render it an outstanding success. Many members of the Society have been serving on the numerous committees engaged in preparatory work, and it is hoped that this Society will be well represented amongst those who register as members for the Congress.

There is one other respect in which members can render help. The Illuminating Engineering Society has undertaken to contribute £250 from its existing funds to the expenditure of the Congress, and it has also intimated its intention of endeavouring to raise an additional £250 from special sources. An appeal from the President in respect of the latter fund has recently been issued. Whilst some generous contributions have been received, the sum so far contributed falls considerably short of that aimed at by the Society. It is hoped, therefore, that any firms represented in the membership of the Society (or otherwise concerned with illumination), who have not already contributed through this or other channels will make a sympathetic response to our appeal.

Kenelm Edgcumbe, *President.*
J. S. Dow, *Hon. Secretary.*

The International Illumination Congress (September 1st to 19th, 1931)

As we go to press we receive the detailed programmes of the International Illumination Congress, with particulars of meetings and visits in each locality and explanatory matter, all presented in English, French and German.

The initial days spent in London should prove exceptionally enjoyable. Technical and pleasure visits will be supplemented by a steamer trip to enable the illuminated buildings on the riverside to be seen. Throughout the subsequent visits to Glasgow, Edinburgh, Buxton, Sheffield, Birmingham and Cambridge technical sessions will be blended with pleasant excursions and social events. We understand that the programme of papers, over 120 in number, will be of a very varied character.

Copies of the programme may be obtained on application to the Hon. General Secretary (Col. C. H. S. Evans, 32, Victoria Street, London, S.W.1). For British delegates the inclusive cost inclusive of accommodation, meals and travelling should not exceed 30s. a day (and in the case of delegates from abroad less), additional to the registration fee of £2. (Ladies accompanying members will be registered free.) The final date fixed for registration is Friday, July 10th, 1931.

Where a country has a National Illumination Committee it is desirable that registration should be made through that committee, but where this is inconvenient registration can be made by anyone through the office of the Hon. General Secretary.

The Natural Lighting of Schools

Report of the Sub-Committee appointed by the Technical Committee of the Illuminating Engineering Society in 1930, *consisting of: Mr. P. J. Waldram (Chairman); Mr. A. Blok and Mr. J. S. Dow (ex-officio), representing The Illuminating Engineering Society; Mr. J. Swarbrick, representing The Royal Institute of British Architects; Dr. Elwin H. T. Nash, representing The Medical Officers of Schools Association; Mr. J. C. Buckley, representing The London Teachers' Association.*

INTRODUCTION.

The Sub-Committee was appointed to undertake the revision of the Interim Report on the Daylight Illumination of Schools issued in 1914* by a Joint Committee formed by the Illuminating Engineering Society. The first task of the Sub-Committee was to explore the available information on the subject of natural lighting issued since 1914†. The Sub-Committee had also been furnished with an informative summary of the Lighting Regulations of School Authorities in the temperate zone prepared by Dr. Elwin H. T. Nash, and it has received valuable information from time to time as to the experience of the Board of Education with regard to many of the problems involved. The views of architects on various aspects of natural lighting in schools have also been ascertained by means of a questionnaire submitted to the Royal Institute of British Architects. A questionnaire was prepared and circulated to Educational Authorities throughout Great Britain with the object of ascertaining particulars of rules and regulations bearing on the natural lighting of schoolrooms. From the result of this enquiry it would appear that the position is similar to that recorded by the sub-committee concerned with the artificial lighting of schoolrooms, namely, that few if any precise regulations of this kind are at present in existence.

The Sub-Committee is satisfied that investigations on many of the subjects indicated at the conclusion of the 1914 Report have been undertaken or are now proceeding, and its present terms of reference do not require it to indicate specific lines of new research.

The Sub-Committee has confined its attention to the provision of adequate penetration of daylight into classrooms; omitting consideration of penetration of *sunlight*, which is being studied by a Committee of the Royal Institute of British Architects in conjunction with the Building Research Station of the Department of Scientific and Industrial Research.

* *The Illuminating Engineer*, Vol. VII, July, 1914, pp. 359-368.

† Amongst contributions which have proved of special interest are the following :—

Home Office : Report of Department Committee on Lighting in Factories and Workshops, 1914-1915.

Department of Scientific and Industrial Research : (Illumination Research) : Technical Paper No. 7, The Penetration of Daylight and Sunlight into Buildings, 1927 : Technical Paper No. 10, The Effect of Distribution and Colour on the suitability of Lighting for Clerical Work, 1930 : Technical Paper No. 11, The Efficiency of Light-Wells, 1930.

Medical Research Council : Report No. VIII of the Committee upon the Physiology of Vision : The Movements of the Eyes in Reading, 1930.

United States Treasury Department : Public Health Bulletin, No. 188, Studies in Natural Illumination in Schoolrooms, 1929.

Royal Institute of British Architects : Natural and Artificial Lighting of Buildings, 1925 (Proceedings, Vol. XXXII, No. 1, p. 13.)

Illuminating Engineering Society : Window Design and the Pre-determination of Daylight Illumination (*The Illuminating Engineer*, April-May, 1923, pp. 89-117).

FUNDAMENTAL PRINCIPLES.

The Sub-Committee approves, in the main, the fundamental principles outlined in the original 1914 Report, but certain modifications, desirable as a result of knowledge since acquired, are indicated in the following clauses.

Access of Daylight determined by Daylight Factor.

At the date of the original report few records of variations in natural lighting throughout the day and during different seasons of the year were available. Records since compiled emphasize the correctness of the assumption that recommendations in regard to adequate natural lighting must necessarily be based on some ratio, preferably the daylight factor as approved at the Session of the International Illumination Commission, held at Saranac (U.S.A.) in 1928‡, correlating the illumination within a room and the unrestricted illumination from the complete sky-hemisphere. Having regard to the variations which occur daily in natural lighting, recommendations cannot usefully be based on absolute values of illumination in foot-candles, as is customary in the case of artificial lighting.

Furthermore, such a ratio should not be based upon an estimated average illumination throughout the year, but rather on the value prevailing on a day when the sky is completely overcast. It should have regard *only* to the reasonably severe conditions of dull, overcast or wet days and should entirely disregard the possibility that in brighter weather the windows may be able to supply the necessary minimum with greater ease.

Proposed International Standard of Daylight.

The International Commission on Illumination has adopted the standard of 5,000 lux (approx. 500 foot-candles)‖ as representing the illumination from an unobstructed hemisphere of overcast sky of uniform brightness for the comparison of photometric data relating to the illumination of interiors by daylight. This appears to be a reasonable criterion of the light from moderately overcast sky in this country. Under such conditions of sky-brightness the daylight factor of 0.5 per cent. mentioned in the 1914 Report would represent 25 lux or 2½ foot-candles.

At the present time there is not any statutory standard of access of daylight into schoolrooms. But it appears that the minimum standard of adequate light for ordinary purposes (*not in schools*) recognized in the Courts since the case of Semon v. Bradford Corporation (1922/2/Ch.) is 0.4 per cent. sill-ratio§ or 0.2 per cent. daylight factor.

Reading Tests.

The Sub-Committee is of the opinion that reading tests or tests involving any given degree of acuteness of vision are unsuitable as criteria of adequate natural illumination in schools. Such tests are

‡ Commission International de l'Eclairage, Septième Session, 1928, Recueil des Travaux, p. 12.

‖ A foot-candle may be defined as the illumination on a surface distant 1 ft. from a source of 1 candle-power and perpendicular to the direction from which the light is received.

§ For definition of sill-ratio and daylight factor see paragraph entitled " Measurement and Predetermination of Daylight Factor " *infra*.

liable to act as a measure of weather conditions rather than of the adequacy of access of natural illumination at the position examined. Futhermore, difficulties imposed by variations in visual capacity on the part of the observer at present appear to be insuperable.

The Sub-Committee considers that by far the most trustworthy test as to whether a school place is above or below any given standard of adequacy is by measurement or predetermination of the daylight factor at that place.

Definition of Adequacy by Reduced Square Degrees.

The Sub-Committee has examined several methods of prescribing access of daylight mentioned in the 1914 Report. It is not satisfied that the criterion of "50 reduced square degrees of visible sky" is comparable in amount with a 0.5 per cent. daylight factor. It is also evident that the criterion of "reduced square degrees" is, in general, difficult to understand and to apply and has not been used in practice even to any small extent. The adoption of this method by architects in school design or by school authorities in testing the suitability of existing school places seems improbable, and the Sub-Committee sees no reason to advocate its retention.

Ratio of Distance of Desk from Window Wall to Height of Top of Glass above Desk.

The Sub-Committee has considered the recommendation in the 1914 Report that no desk should be further from the window than twice the height of the top of the glass above the desk surface. Whilst such a rule may be of some service as a rough guide to window-design it does not appear to have any scientfic basis. In most cases its provisions would automatically be secured by adherence to any reasonable standard based on a daylight factor.

Light obtained by Reflection from Outside Surfaces.

The Sub-Committee is of opinion that light obtained by reflection from external wall surfaces is not sufficient for the adequate illumination of a school place without direct light from sky visible from the desk. This view is confirmed by an examination of recently published data*.

The Sub-Committee has also carried out some tests as to the comparative value of borrowed lights and of solid wall surfaces of different reflecting values. The results tended to confirm the general conclusions adduced in the 1914 Report, in which a preference for opaque partition-surfaces of good reflecting value was expressed.

MEASUREMENT AND PREDETERMINATION OF DAYLIGHT FACTOR.

At the time when the 1914 Report was issued the measurement of the daylight ratio, either in terms of the "daylight factor," i.e., the ratio of the illumination at a place in a schoolroom to the illumination derived from a complete hemisphere of sky, or the "sill-ratio," i.e., the ratio of the illumination on a desk in a schoolroom to the illumination derived from a quarter-sphere of sky, measurable on the window-sill was still comparatively a novelty†. At the present time such measurements have become familiar. The Sub-Committee is satisfied that methods of well-established accuracy are in use whereby the daylight factor of any school place can, in general, be determined without difficulty from drawings, even when outside obstructions are irregular. Such methods have been made known to architects for some years; they are customarily applied in disputes as to light, and they are now recognized in the Courts.

Optical and photographic methods of determining the daylight ratio simply by observation of the sky subtended at any existing school desk have recently been devised, and simple apparatus for this purpose, requiring no adjustment and suitable for use by persons unskilled in photometry, has been brought to the attention of the Sub-Committee.

* D.S.I.R., Illumination Research Committee, Technical Papers Nos. 7 and 11.

† It will be observed that a given daylight factor is numerically one-half the corresponding sill-ratio, i.e., a daylight factor of 0.5 per cent. is equivalent to a sill-ratio of 1 per cent.

RECOMMENDATIONS.

I. VISIBILITY OF SKY.

(i) No position in a classroom from which no sky is visible at desk or table height is fit for use as a school place.

(ii) The area of sky visible should be sufficient at least to afford an illumination on a horizontal plane at desk or table height equivalent to a daylight factor of 0.5 per cent.†, i.e., 0.5 per cent. of the illumination from a complete hemisphere of sky all parts of which are equally bright, such as would illuminate the surface of an unobstructed flat roof.

II. LOCATION OF WINDOWS.

(i) Windows for lighting desks should preferably be located in the walls to the left of the pupils. With such left side lighting windows in the walls to the right of the pupils should be designed mainly in order to aid cross ventilation or for the purpose of admission of sunlight at periods when the pupils are absent.

(ii) Where left side lighting is impracticable right side lighting is the next best method.

(iii) Roof lighting as the sole means of illumination is undesirable.

(iv) Windows in the walls facing the eyes of pupils or teachers are highly objectionable.

III. DETAILS OF WINDOWS.

Window heads should be horizontal. The glass should be carried up to ceiling level and should not be obstructed by large mullions or transomes, sash bars, ornamental features, pillars, cornices, etc. Glass should be clear and should be cleaned at fixed intervals. All types of glass which obstruct light and/or are difficult to keep clean and in repair should be avoided.

IV. DECORATION.

(i) The ceiling should preferably be white and the walls and other decorations above the dado should be light in tint.

(ii) Desks and furniture should be of a light and unobtrusive colour; dark shades and black should be avoided.

(iii) So far as possible specular reflection of sunlight from any surface into the eyes of pupils or teachers should be prevented.

† This value is regarded as a minimum which may be materially exceeded in new schools, where a daylight factor of 1 per cent. should be aimed at. It should also be borne in mind that the reflection of light from walls and ceilings makes a substantial addition to the available illumination in a schoolroom, and further that the absence of hard shadows and severe contrasts, which is characteristic of daylight, precludes true comparisons with standards imposed by conditions of artificial lighting.

The Artificial Lighting of Schools

Report of the Sub-Committee appointed by the Technical Committee of the Illuminating Engineering Society in 1930, *consisting of: Mr. A. Blok (Chairman); Mr. J. S. Dow (ex-officio); Mr. W. J. Jones; Dr. A. H. Levy; Mr. E. L. Oughton; Mr. T. E. Ritchie and Mr. P. J. Waldram (representing The Illuminating Engineering Society); Mr. J. Swarbrick (representing The Royal Institute of British Architects); Dr. Elwin H. T. Nash (representing The Medical Officers of Schools Association); Mr. J. C. Buckley (representing The London Teachers' Association); and Dr. R. J. Lythgoe.*

INTRODUCTION.

In view of the fuller knowledge in the science of illumination that has been attained, and the technical advance that has taken place since 1913, the Sub-Committee was requested to undertake a revision of the Report of the Joint Committee on the Artificial Lighting of Schools published in that year.* As a preliminary to such revision, the Sub-Committee undertook a study of the existing regulations, codes and literature bearing on this subject. A questionnaire was also prepared and circulated to educational authorities throughout Great Britain, with the object of ascertaining particulars of rules and regulations in force bearing on the lighting of schoolrooms. From these inquiries it was concluded that few if any precise regulations of this kind are at present in existence. It also appeared that no results of satisfactory scientific research into the relation between lighting conditions in schools and the well-being or performance of work of pupils, such as would form a necessary basis for standards and regulations, had been published. A comprehensive inquiry of this description, which the Sub-Committee is now initiating, may occupy a considerable time, and the possibility of forming definite conclusions as a result cannot yet be judged. But it has been suggested that, pending the result of this inquiry, a series of recommendations based on general experience and on observations of what is considered by the Sub-Committee to be good modern practice would be of utility, especially as a guide to lighting methods in new schools. The following series of recommendations has been prepared solely on this basis.

In regard to the recommended values of illumination specified, it should be clearly understood that these are minima, which, in some circumstances, may be advantageously exceeded in practice. Furthermore, as no system of lighting is completely uniform the minimum illumination will necessarily be exceeded in certain parts of a schoolroom. Finally, it should also be remembered that there are at least three factors which cause a progressive diminution in the illumination in a given room, viz. (*i*) the accumulation of dust or dirt on the glassware of lighting fittings, (*ii*) depreciation of the reflecting value of the walls and ceiling due to the accumulation of dust or dirt, and (iii) deterioration of the illuminants themselves, whether electric lamps or gas mantles. Experience shows that these causes may reduce the illumination by 20 or 30 per cent. of its initial value in six weeks if local conditions are sufficiently unfavourable. These factors of depreciation should, therefore, be taken into account when the installation is initially planned, in order that the minimum values of illumination recommended below may be obtained when the depreciating conditions are at their worst.

* *The Illuminating Engineer,* July, 1913, pp. 364-366.

RECOMMENDATIONS.

Subject to the foregoing remarks the recommendations of the sub-committee are as follows:—

I. Illumination.

The minimum illumination provided should be:—

(i) *On desks and tables in schoolrooms,* measured on the desk, table or other surface on which the work is done, (*a*) 5 foot-candles† for ordinary clerical work (reading and writing) and (*b*) 8 foot-candles for special work (in art classes, drawing offices, workshops and sewing rooms where dark materials may be used).

(ii) *On blackboards,* measured on the plane of the board, 60 per cent. in excess of the illumination measured on desks or tables.

(iii) *In assembly rooms and recreation rooms.* 3 foot-candles measured in a horizontal plane 2 ft. 9 ins above the floor level.

(iv) *General illumination.* Apart from the minimum values recommended above, in no part of any school building should the illumination be less than 1 foot-candle, this being measured, in the case of stairways, upon the tread surface of the stairs and in other places being measured in a horizontal plane 2 ft. 9 ins. above the floor level.

II. Avoidance of Glare.

Great importance should be attached to avoidance of glare such as is liable to arise (*a*) from the display in classrooms of unscreened gas mantles or lamp filaments within the direct range of vision ("direct glare") or (*b*) from the reflection of light-sources in polished or glazed surfaces ("reflected glare").

With a view to avoiding direct glare it is recommended that:—

(i) No incandescent surface or brightly illuminated reflector or similar surfaces forming part of lighting fittings should be visible to the eyes of teacher or pupils while carrying on their ordinary work, and sources of light should preferably be surrounded by a diffusing medium such that its average brightness does not exceed 5 candles per square inch of surface area.

(ii) No source of light should be situated below a line drawn from a point on the back wall 3 ft. 6 ins. above the floor to a point 4 ft. above the upper edge of the blackboard surface, unless it is completely screened from the eyes of pupils by an opaque screen. In the case of a room having a sloping or stepped floor rising away from the blackboard, the 3 ft. 6 ins. is to be measured from the elevated floor surface at the end of the room remote from the blackboard.

† A foot-candle may be defined as the illumination on a surface distant 1 ft. from a source of 1 candle-power and perpendicular to the direction from which the light is received.

(iii) The fact that staircase lighting involves considerations of safety should be borne in mind. Special precautions should therefore be taken to avoid glare from sources of light used to illuminate stairways, especially as regards persons *descending* the stairs.

With a view to avoiding reflected glare it is recommended that:—

(i) Special care should be devoted to (*a*) the selection of the blackboards, the surfaces of which should be maintained in a dark and matt condition, and (*b*) the positions of light-sources in relation to blackboards in order to avoid specular images of the sources in the line of sight.

(ii) The surfaces of walls, ceilings and, so far as possible, furniture, should be of such a surface texture that any considerable specular reflection is avoided (glazed and shiny surfaces above the dado are specially objectionable.)

(iii) So far as possible books intended for the use of children should be printed on paper that is free from glaze. The use of highly glazed paper for writing upon should also be avoided.

The use of lighting equipment of low surface brightness, as a means of diminishing direct glare, is also of value in reducing reflected glare, as the brightness of the reflected image is less.

Light-coloured surroundings, by diminishing the contrast between light-sources and their backgrounds, are helpful in reducing direct glare, and the diffusion of light by this means also aids in rendering reflected glare less evident.

III. Avoidance of Objectionable Shadows.

The number and position of lights should be so chosen that objectionable shadows cast by the body or by columns or other structural features of the room on the desk or other places where the work is done are avoided.

Such shadows are least evident when:—

(i) The sources of light are surrounded by diffusing media such as extend the luminous surface and therefore give rise to soft shadows, and

(ii) The walls and ceilings are light in colour, and thus serve as extended secondary sources of low brightness. The ceilings should preferably be white and the walls and all decorations above the dado should be light in tint.

In view of the importance of adequate lighting of stairways in the interest of safety, lights should be so arranged that shadows of risers on the treads are avoided.

IV. Positions of Light-Sources.

(i) *In Classrooms.* Classrooms approximately of the standard size (i.e., about 480 sq. ft.) may conveniently be lighted efficiently by four suitable lighting units† distributed symmetrically above the desks, but supplementary illumination for the teacher's area and the blackboard by two additional units is sometimes desirable. With a view to avoiding glare it is important that the lights be kept well out of the normal line of vision. Where practicable a height of suspension of not less than 10 ft. is to be desired. Special importance attaches to supplementary lights intended to illuminate the blackboard or the teacher's area, as these are more liable to come within the direct view of pupils, and because incorrect location is liable to give rise to troublesome reflected light from the blackboard surface. For these reasons it is desirable to make the height of suspension of such additional sources of light as great as possible, and to pay special attention to screening.

(ii) *On Stairways.* Light sources should be so placed that each flight of stairs is illuminated both from above and from below.

V. Depreciation and Maintenance.

As deposits of dust result in rapid diminution in the available illumination, it is expedient that all lamps and lighting fittings should be overhauled and cleaned at intervals of not more than one month. For general lighting modern forms of enclosed fittings which are less liable to suffer from the entrance of dust are to be preferred.

† See paragraphs II (i) and V.

National Physical Laboratory

Annual Visit

There were, it seemed to us, more visitors than ever at the National Physical Laboratory on the occasion of the inspection by the General Board on June 23rd. On this occasion the apparatus staged in sections devoted to illumination and photometry was, in the main, familiar. Interest was again expressed in the 10-ft. integrating sphere and the special illumination building for daylight experiments. We learned that steady progress is being made with the design of standard lamps of the gas-filled type, and that photo-electric testing is still being studied and improved.

Of other exhibits those concerned with aircraft attracted special attention. The new compressed air tunnel, which enables models to be tested under conditions directly comparable with those applying to full-scale machines, was entered by many visitors, and the adjacent apparatus and experiments in the high-tension building, where pressure up to 1,200,000 volts are available, inevitably attracted notice.

The N.P.L. is traditionally favoured by the weather on such occasions. The charming outlook over the sunlit playing-fields adjacent to the laboratories must have made visitors envious of such delightful working surroundings!

The Automatic Control of Lighting Installations

The automatic control of street lamps by means of photo-electric or selenium cells is attracting much interest, and in some areas promising results have been obtained. The automatic control of artificial lighting in interiors is, in some respects, a more difficult problem. The usual method of leaving the point when artificial light is turned on to the caprice of the user is not entirely satisfactory—especially in schools or factories where the needs of a number may be dominated by the action of one. Forgetfulness, preoccupation or perverse economy may all lead to the moment being too long delayed. A device described by Mr. E. H. Vedder and Mr. S. G. Hibbin is based on the use of a photo-electric cell equipped with amplifier and subject to light from all directions* This can be adjusted to turn on lights when illumination falls below a predetermined value. Two limiting conditions are suggested: (1) the natural illumination at which the unit turns on should at least be equal to and never less than the artificial illumination and (2) the natural illumination at which the unit turns off should be approximately twice the turn-on value.

* *Trans.* Illuminating Engineering Society, U.S.A., May, 1931, pp. 517-525.

The Artificial Lighting of Libraries

(Issued by the Illuminating Engineering Society, and the Library Association)

[*Report of the Sub-Committee appointed by the Technical Committee of the Illuminating Engineering Society in* 1930, *consisting of*: *Mr. J. S. Dow* (*ex-officio*), *Mr. J. Eck, Dr. S. English* (*chairman*), *Mr. H. Lingard, Mr. P. Sugg, and Mr. G. H. Wilson, representing the Illuminating Engineering Society; and Mr. J. Wilks and Mr. D. S. Young, representing the Library Association.*]

I.—Terms of Reference of the Committee.

THE Committee was requested to undertake the revision of the Report of the Joint Committee on Library Lighting published in 1913.* Its aim has therefore been to bring an existing report up to date rather than to undertake original experimental investigations on Library Lighting.

Advances in methods of lighting, and developments in library technique which have occurred since 1913, rendered revision desirable at an early date. It was therefore considered inexpedient to attempt prolonged investigations on such general problems as the effect on vision of the intensity of illumination, the colour of light, and the brightness of surrounding objects. Such records as exist of fundamental work of this nature have been considered. But the recommendations now made are based mainly on the observation of good modern practice as illustrated in a number of libraries, both of the public and specialized type. In the course of the visits of inspection to such libraries, measurements of illumination were made and records kept of the positions and nature of light-sources and other similar factors likely to affect the comfort of the reader.

II.—Notes on General Principles of Lighting.

The main requirements for adequate and suitable lighting in libraries are:—

(1) *Sufficient illumination* for the purpose in view specified in foot-candles† and measured on the actual surface where the light is needed.

(2) Avoidance of troublesome dazzle or glare, arising either directly from inconveniently bright light-sources ("direct glare") or indirectly from the reflection of light in highly-glazed or polished surfaces ("reflected glare").

(3) Avoidance of troublesome shadows cast on books or papers (especially head shadows).

These and other requirements will be considered in detail in reviewing the chief problems that arise in lighting libraries. Attention may, however, be drawn at the outset to two conditions which invariably exert a marked influence on conditions of illumination.

In the first place, it is desirable to avoid dark colours for walls and ceilings which absorb much light. Ceilings should preferably be finished in white and walls in a light colour. Diffused reflection of light from such surfaces furnishes a valuable addition to the available illumination on shelves and tables. Even more important is the resultant softening of the shadows and the diminution in the contrast between the brightness of light-sources and their surroundings.

In the second place, it is expedient to avoid so far as possible polished and glossy surfaces, in which images of light-sources are liable to be formed. Walls and ceilings should have a matt finish. Furniture and woodwork, especially the surfaces of reading tables and newspaper stands, should also preferably be left unpolished.

* *Illum. Engineer*, July, 1913, pp. 366-367.

† A foot-candle may be defined as the illumination on a surface distant one foot from a source of one candle-power and perpendicular to the direction from which light is received.

III.—Lighting of Reading Rooms.

Adequate general lighting should be employed throughout the library. The recommended minimum illumination at table height for reading purposes is 5 foot-candles.‡ This illumination may be obtained by general lighting alone or by a combination of general and supplementary local lighting.

When reading-lamps furnishing supplementary local lighting are employed the minimum value of the general illumination measured at table height throughout the room should be 1 foot-candle,§ additional to the illumination furnished by reading-lamps.

If the reading illumination is furnished by overhead general lighting units, some care is necessary to avoid troublesome shadows being cast on books or periodicals by the heads and shoulders of readers. In order to avoid such shadows, and to promote even distribution of light, the lighting units should be spaced a distance apart not exceeding one and a half times their height above the floor. As they can, if necessary, be spaced closer together than this, it will generally be possible to arrange the lighting points so that the unit comes over the centre line of each table (see Fig 1). If the lighting units are at heights of 12 ft. and upwards, little trouble from head-shadows or reflected glare should be experienced. Such troubles are further reduced when sources of light are equipped with diffusing glassware and when the shadows and contrasts are further softened by the presence of suitably-coloured walls and ceilings.

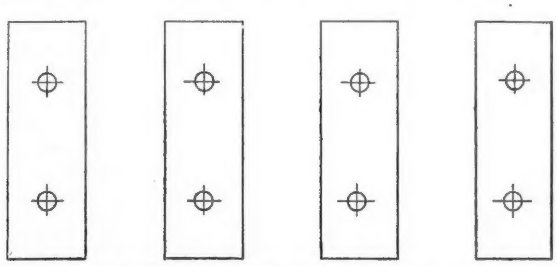


Fig. 1.—Plan of Tables, showing Lighting Units over centre-lines.

In order to limit "direct glare," it is desirable that no unshaded lamp filament or gas mantle should be visible at any angle to persons reading at

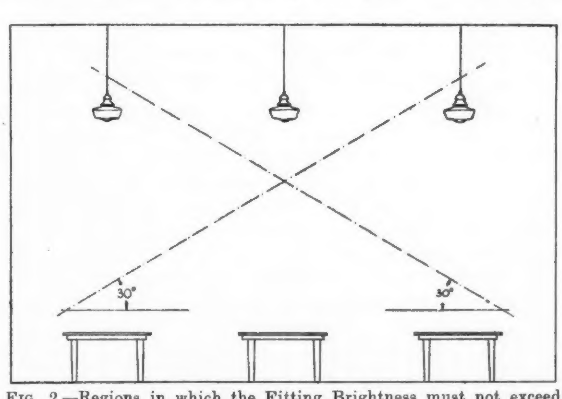


Fig. 2.—Regions in which the Fitting Brightness must not exceed the figure specified.

‡ See Section VII.

§ See Section VII.

tables. It is also advisable to place a limit on the surface brightness of the envelopes that are used to surround lamps and gas-burners when these lighting units are visible at an angle of less than 30° from a horizontal line of sight of persons sitting at reading tables. When viewed within such an angle, the average brightness should not exceed 5 candles per square inch, and no portion of the unit should have a brightness of more than 25 candles per square inch (see Fig. 2).

(Any diffusing unit complying with British Standard Specification No. 324, 1928, will have a maximum brightness not exceeding 5 candles per square inch. This brightness is approximately that obtained on an exterior of a 12 inches diameter opal sphere containing a 300-watt incandescent lamp.)

With a view to minimizing reflected glare and shadows cast by folds or wrinkles in newspapers, a well-diffused source of light is desirable. The reflectors may, therefore, be faced with diffusing glass. The vertical surface of the reflector may also have an insert of opal glass, bearing the names of the newspapers and rendered luminous by the lamp within (see Fig. 4).

V.—Lighting of Book Shelves.

The position of the general lighting units relative to book shelves should be such that objectionable shadows are not cast by the reader's body upon the backs of the books with the reader in any normal position. The minimum illumination on the backs of the books should be 2 foot-candles.†

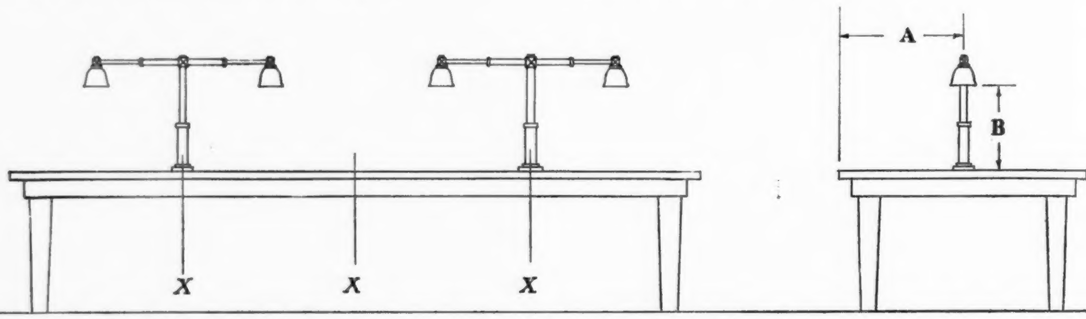


Fig. 3.—Recommended height of Table-Lamps. (x x x are most suitable reading posions: the ratio A/B should not be less than 3/2.)

When supplementary local lighting of reading tables is employed, the illumination on the tables from all sources should not be less than 5 foot-candles,‖ and the general illumination, as already stated, should not be less than 1 foot-candle.¶

Direct units—i.e., units directing not less than 90 per cent. of the total flux into the lower hemisphere—should be adopted for local lighting. The shades employed with stand-lamps on tables should be either opaque or of very low surface brightness—i.e., a brightness not exceeding one candle-power per square inch—and should be of such a depth that incandescent mantles or electric-lamp bulbs do not protrude below the level of the lower rim. With a view to avoiding striations or inequalities in illumination diffusing bulbs should preferably be adopted with electric lamps.

The lighting unit, if of a fixed nature, should preferably be so placed that the ratio of the distance of the centre of the standard from the edge of the table to the height of the lower rim of the shade above the table is not less than three to two (see Fig. 3).

Compliance with these conditions should afford protection against direct glare and should diminish reflected glare from polished or glazed surfaces to a minimum.

IV.—Lighting of Newspaper Stands.

It is most usual to rely on the general lighting in a reading-room for the illumination of newspaper stands, but in some cases, owing to the difficulty in avoiding shadows cast by the head and shoulders of standing readers, supplementary local lighting may be desirable. A convenient method of providing this additional light is by means of tubular lamps in trough reflectors, situated slightly above and about 1 foot in front of the top line of the stand, and completely concealing the lamp from the eyes of readers. The illumination from all sources on the surface of the stand should not be less than 5 foot-candles.*

‖ See Section VII.
¶ See Section VII.
* See Section VII.

Special book-shelf lighting may be used with advantage, in which event the units should be situated at the top of the book shelves and arranged somewhat in front of the book shelf, so that the light may be most efficiently directed on the backs of volumes.

Better illumination of the backs of books may be obtained by tilting the lower shelves, as shown in Fig. 5.

VI.—Lighting of Card Index Cabinets.

The minimum illumination on card index cabinets should be 5 foot-candles. The units should be so situated relative to the cabinet that no objectionable shadows are thrown on the cards either by the other cards in the drawer or by the reader. Where individual lighting units are employed these should be mounted above the front edge of the cabinet.

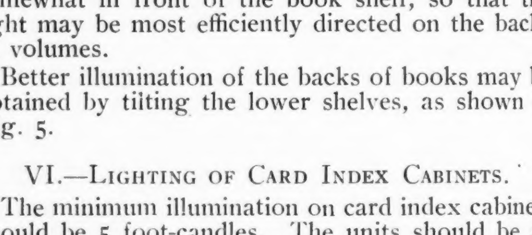


Fig. 4.—Lighting of Newspaper Stands.

VII.—Conclusion.

In conclusion, the Committee desires it to be clearly understood that the values of illumination mentioned above are *minimum* values, such as may often be advantageously exceeded in practice; it should also be remembered that, owing to ageing of lamps, and deposits of dust on lamps, fittings, walls and ceilings, the original illumination provided in a new installation tends to diminish in course of

† See Section VII.

time. A suitable depreciation factor, varying from 25 to 35 per cent. according to circumstances, may therefore be applied.

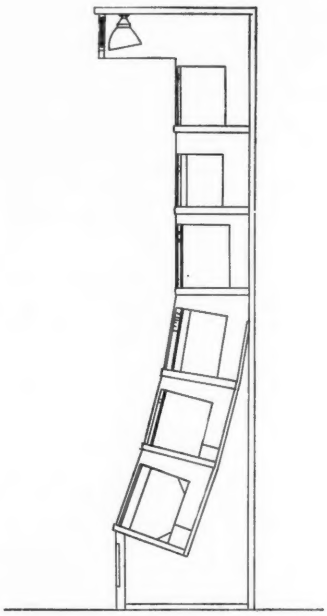


FIG. 5.—Section of Bookcase with tilted shelves.

Compliance with the foregoing recommendations should enable satisfactory results, according to present lighting standards, to be obtained in most libraries. The Committee, however, will be pleased to consider any special problems that may be brought to their notice.

Electrical Association for Women

SECOND INTERNATIONAL CONFERENCE

Lady Moir's Presidential Address to the Electrical Association for Women at their conference in Glasgow on June 4th made reference to the remarkable progress of this body. Although the Association has only been in existence for about six years it can now count over 5,000 members and there are 25 active branches in various parts of the United Kingdom. Other countries were well represented at the conference, where accounts of progress in France, Sweden and Denmark were presented. It is perhaps inevitable that the attention of the E.A.W. should be concentrated largely on domestic heating, cooking and other domestic applications of electricity. We hope, however, that the primary problem of providing efficient agreeable lighting in the home will not be overlooked.

The Royal Sanitary Institute

FORTY-SECOND CONGRESS, 1931

The forty-second congress of the Royal Sanitary Institute takes place in Glasgow during July 4th-11th inclusive. The inaugural address is being delivered by Sir Henry Mechan, D.L., LL.D. The list of subjects is varied and an attendance of about 1,400 is anticipated. These annual congresses seem to present an excellent opportunity for discourses on hygienic aspects of illumination and we hope that the advantage will be taken of this next year and that papers illustrating the benefits of good lighting to health will figure in the programme.

The Illuminating Engineering Society of Australia

New Organization Formed

(*Communicated.*)

PROMINENT business men in Australia have, for a long while, seen the necessity of linking together those interested in the general advancement of illuminating engineering and the utilization of light. To promote these objectives, The Illuminating Engineering Society of Australia has been inaugurated in Sydney.

The inaugural General Meeting was held in October. At this meeting the following Officers of the Council were elected:—

President: A. P. Turnbull, Esq. (N.S.W. Government Railways).

Vice-Presidents: E. W. Williams, Esq. (Australian General Electric Co. Ltd), and H. P. Moss, Esq. (Commonwealth Department of Works).

Honorary Technical Secretary: H. G. Fallon, Esq. (Municipal Council of Sydney).

Honorary Treasurer: L. Lord, Esq. (Philips Lamps (A/asia) Ltd).

Members of Council: Messrs. W. R. Caithness (British General Electric Co. Ltd.), W. H. Goodridge (J. C. Williamson Ltd), L. E. Cooke (N.S.W. Government Railways), L. D. Wright Municipal Council of Sydney), B. S. Swift (Robt. Bryce & Co. Ltd.), and W. F. Crowley (Government Architects' Branch, Public Works Department, N.S.W.).

Secretary: Mr. Andrew F. O. Brown.

A satisfactory feature of the Society is that practically every phase of industry and commerce is represented on the rapidly growing membership roll. These members include executives of the railways and tramways departments, Government public works, electric supply authorities, Government Architects' Branch, and commercial houses, and those manufacturing lighting equipment, while users are represented by theatre and public entertainment companies.

As far as could be arranged, each of these groups is represented on the Council, and there is little doubt that the new Society will have a very strong influence in the development of the science of applied illumination in Australia. Regular monthly meetings will be held, and interesting lectures have been arranged.

Communications may be addressed to the Secretary, Illuminating Engineering Society of Australia, The Grace Building, King Street, Sydney.

Since the receipt of the above account of the formation of the Illuminating Engineering Society of Australia we have observed with interest in *The Australian Engineer* an account of a monthly general meeting of the Society at which a paper on Street Lighting by Mr. H. G. Fallon was read.

The same journal contains an account of the inaugural meeting of the Victorian division of the Illuminating Engineering Society which was held on April 16th. An address was delivered by Professor E. B. Brown, the newly-elected President, who took a wide view of "illuminating engineering," emphasizing especially the need for taking into consideration the behaviour of the human eye.

The Evaluation of Glare in Street-lighting Installations

By W. S. STILES, Ph.D.

1.—Introduction.

Glare has long been recognized as a factor of importance in street lighting, but the problem of devising means to enable the illuminating engineer to predict from the character and arrangement of his fittings whether his street-lighting installation will be glaring, and, if so, how serious the glare will be, still remains to be solved. The prime difficulty when dealing with glare is that we are confronted not with a simple phenomenon but with a whole group of more or less interrelated effects.* It has been necessary to study separately the more important of these glare effects, and the laws to which the different effects conform have been found to differ in essential particulars. There is thus no hope of obtaining a method of measurement which will give the magnitude of the glare in a given case, as a single number. Methods can be devised, however, which enable the magnitude of the more important glare effects to be evaluated separately. From the illuminating engineer's point of view the glare effect of greatest interest is reduction of eye sensitivity. A considerable amount of laboratory research has been carried out on this aspect of glare, and the application of the results to practical illuminating engineering has commenced. An important step in this direction was taken by the B.E.S.A. Street-lighting Committee in 1927, when they incorporated into their Street-lighting Specification a glare clause. The glare clause contained a method for evaluating the impairment of visibility due to the street-lighting fittings, and prescribed that the amount of this impairment should not exceed a certain value. The object of the present note is to suggest a new method for defining a glare figure, and to show how it can be applied to the case of street-lighting installations. (An important difference between the present method and that of the specification is discussed in Section 5.) *The method, and the glare figure obtained by its aid, refer expressly and solely to one effect of glare, namely, reduction in ability to see (disability glare). The reduction in eye sensitivity is, of course, only one of the effects of glare. Others are the discomfort experienced by the observer and the distraction of his attention by the glaring sources. Although these effects may vary in the same general way as the effect on eye sensitivity, this is not known to be the case, and determinations of conditions of minimum glare based on eye-sensitivity data may not give conditions of least discomfort and least distraction.* Furthermore, *a condition of glare in which the effect on eye sensitivity is relatively small may yet produce more discomfort than would be reckoned tolerable.* The question of the relative importance of disability glare and discomfort glare in the case of street lighting is occupying attention at the present time. It appears that both effects have to be considered. Perhaps in the future it will be possible to determine two glare figures—one for discomfort, one for disability glare.

2.—Definition of a Glare Figure for Disability Glare.

We can measure an observer's "ability to see," when he is looking in a given direction under given lighting conditions, by determining the least difference of brightness which he can detect, that is to say, by determining the brightness difference threshold δB. The smaller δB is, the greater the ability to see. Suppose δB has been determined for a case in which the field of view contains glaring sources of light, and suppose it is contrived to shield these glare sources from the observer's view, without altering in any way the brightness distribution in the field. The new value of the brightness difference threshold (δB_0) will be less than the original value (δB), because the glaring effect of the light-sources has been eliminated. The natural definition to choose for the glare figure is $g = \frac{\delta B}{\delta B_0}$. This definition can be formulated quite generally, whatever the number, intensity, or distribution of the glare sources may be. As explained in some detail elsewhere,* the value of δB has been determined by experiment under widely varying glare conditions, and the results have been put into the following form: If there is a single glare source in the field, separated by an angle θ from the direction of vision, and producing a vertical illumination of E foot-candles at the eyes of an observer, the value of δB is the same as would be obtained if the observer viewed a glareless field of brightness β where $\beta = B + \frac{KE}{\theta^n}$ and B is the brightness of the field actually viewed. K and n are constants, for which values have been obtained in recent measurements. If there are two glare sources,

$$\beta = B + K\left\{\frac{E_1}{\theta_1{}^n} + \frac{E_2}{\theta_2{}^n}\right\}$$

and similarly for any number of glare sources. To obtain δB from β, use must be made of the experimentally determined relation between the brightness difference threshold and the field brightness in the absence of glare. This is usually represented by giving the Fechner fraction, $F = \frac{\delta B}{B}$, for each value of B. Using the above formula, the glare figure $g = \frac{\delta B}{\delta B_0}$ becomes

$$g = \frac{\delta B}{\beta}\cdot\beta \Big/ \frac{\delta B_0}{B}\cdot B = \frac{F}{F_0}\quad\frac{\beta}{B}$$

$$= \frac{F}{F_0}\left\{\frac{B + K\left(\frac{E_1}{\theta_1{}^n} + \frac{E_2}{\theta_2{}^n} + \;.\;\;.\;\;.\;\;.\right)}{B}\right\}$$

where F and F_0 are the Fechner fractions for fields of brightness β and B respectively. It the Fechner fraction were a constant for all field brightnesses (as was once supposed), F would equal F_0, and g would reduce to $\frac{\beta}{B}$, a straightforward formula enabling g to be calculated in terms of the ordinary measurements of illuminating engineering. Unfortunately, F is not a constant, but for brightnesses greater than about 10^{-2} candles per square foot it varies only slowly with brightness. For brightnesses lower than 10^{-2} candles per square foot F varies much more rapidly with B. It is of interest to see what happens if the glare figure is *defined* to be $g' = \frac{\beta}{B}$ instead of $g = \frac{\delta B}{\delta B_0}$. One finds that where the glare effect is small, g' and g are approximately identical. As the magnitude of the glare increases, g' rises more rapidly than g, this difference in behaviour being more pronounced at brightnesses lower than 10^{-2} candles per square foot. For any two cases in which the general level of brightness has about the same value the one with the greater g will also have the greater g'. There are both disadvantages and advantages in working with g' rather than g, but it appears to the writer that, on the whole, it is preferable to adopt g' as the glare figure. The following calculations have therefore been based on the definition, glare figure g (dropping the accent)

$$= \frac{\beta}{B} = 1 + \frac{K}{B}\left\{\frac{E_1}{\theta_1{}^n} + \frac{E_2}{\theta_2{}^n} + \;.\;\;.\;\;.\;\;.\right\}$$

The values of the constants K and n were found by Holladay to equal 9.2 and 2 respectively, for a range of θ from 2.5° to 25°. The values obtained by Stiles in the range $\theta = 1$ to $\theta = 10°$ were $K = 4.16$, $n = 3/2$, and these values will be accepted in what follows. It should be noted that the numerical value of $K = 4.16$, assumes that B is expressed in candles per square foot, E in foot-candles, and θ in degrees.

* See Millar & Gray, *Proceedings* of the International Commission on Illumination, 1928, p. 239; and Stiles, *Illuminating Engineer*, December, 1929, p. 304.

* Stiles, *loc. cit.*

3.—APPLICATION TO STREET LIGHTING.

Consider an observer standing in an artificially illuminated street. For every position of the observer, and for every direction of view (below the horizontal), a value of the glare figure g can be obtained.

The street lamps are to be regarded as the glare sources producing respectively vertical illuminations E_1, E_2, etc., at the eyes of the observer. The first lamp is separated from the observer's direction of vision by the angle θ_1, the second lamp by the angle θ_2, and so on. The general level of brightness in the street is denoted by B. The glare figure g is given by

$$g = 1 + \frac{4 \cdot 16\, E_1}{B\, \theta_1^{1 \cdot 5}} + \frac{4 \cdot 16\, E_2}{B\, \theta_2^{1 \cdot 5}} + \text{etc.}$$

each fitting contributing an amount $\frac{4 \cdot 16\, E}{B\, \theta^{1 \cdot 5}}$

The question next arises as to how the installation as a whole is to be appraised from the standpoint of glare. With the idea of preventing dangerous glare, it seems that the maximum value of g is of chief interest. If the glare effect of the first lamp alone is considered, the determination of the maximum value of g can be accomplished quite simply by a method on the same lines as that given in the B.E.S.A. Specification. When the glare effects of more than the first lamp are taken into account, the determination of the position of maximum glare is more complicated. An observer standing in the middle of a long street without inclines or bends sees, when his gaze is horizontal and along the length of the street, a series of light-sources producing a steadily decreasing illumination on the eyes, which converge on to a point in the distance, which is in fact the point at which he is looking. The value of g can be obtained for these conditions of vision at observation points all along the span, and the position of maximum glare determined. Now as regards the distant lamps which make only small angles with the direction of vision (the second lamp will subtend an angle of the order 7° with the horizontal, the third 4°, and so on), a small change in the direction of vision will have a very large effect on the glare contributions due to these lamps. If these glare contributions form a large part of the total glare effect (which the Sheffield investigation shows to be the case), it follows that in the ideal street described above, shifting the gaze a few degrees on either side of the convergence point of the lamps will result in large changes in g. In practice we never have to do with an ideal street, but always with streets containing bends and inclines. These result (*a*) in making the determination of the true maximum g for any particular street and observation point a practically impossible problem, (*b*) in giving widely different values of g for different streets with identical lighting installations but slightly different bends and inclines.

The above discussion indicates that when the glare effect from all the lamps seen is considered, it is not practicable to base glare restrictions on the glare value obtained at the position of worst glare.

One way out of this difficulty is to work with *the glare effects averaged over the important directions of vision.* By the important range of directions of vision we mean directions of vision whose separations from the (principal) horizontal, parallel to the street, line do not exceed a certain limit, say 10°. As regards the glare effect from the first lamp, at the observation position at which its glare effect is a maximum, the average value will not differ a great deal from the maximum value. This follows because the angular separation of the lamp direction from the principal direction is usually fairly large (of the order of 30°). It will be desirable, therefore, to continue to work with the maximum glare effect due to the first lamp.

We proceed now to develop a method for determining a glare figure for an installation, and begin with finding the maximum glare contribution of the first lamp. It will be assumed at first that the installation is a central system employing symmetrical fittings. We have to find the value of θ, for which the glare contribution $\frac{4 \cdot 16}{B} = \frac{E}{\theta^{1 \cdot 5}}$ due to the first lamp, is a maximum. It is clear that $\frac{E}{\theta^{1 \cdot 5}} = \frac{I_\theta}{(h-5)^2} \frac{\sin^2\theta\cos\theta}{\theta^{1 \cdot 5}}$ where I_θ is the candle-power of the lamp in a direction making an angle θ with the horizontal. A set of values of $\frac{\sin^2\theta\cos\theta}{\theta^{1 \cdot 5}} = A$ for different values of θ, is given in Table I. For each value of θ, A is multiplied by I_θ (read off from the polar curve of the fitting), and the product plotted against θ. The angle θ, for which the product $I_\theta A$ has is maximum value, defines the position of maximum glare. Calling this angle θ_m, the maximum glare contribution due to the first lamp is given by $T_1 = \frac{(I_\theta A)_m}{(h-5)^2} \cdot \frac{4 \cdot 16}{B}$. If the installation is not central, but a staggered or single side system, the maximum glare contribution of the first lamp will be less, and to allow for this the above result must be multiplied by a factor λ, the values of which are given in Table IV. The method of obtaining λ is explained in Appendix I.

Take now a distant lamp in the field of view. Owing to bends and inclines in the street, and other incidental factors, it cannot be predicted at what point in the field the light-source will be seen, except that we know this point will probably fall near to the principal direction. In arriving at the average glare effect due to this lamp, we shall assume that it is legitimate to replace the range of directions about the principal direction by a range about the lamp direction. When this is done the average effect can be quite simply calculated. In Fig. 1 let

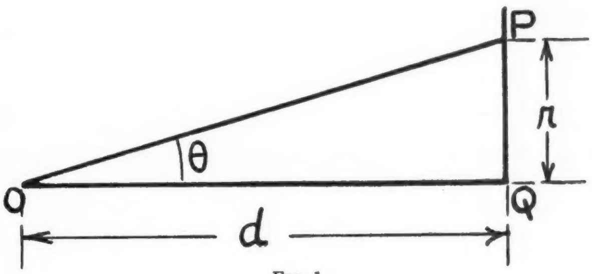


FIG. 1.

d be the distance of the light source Q from the observer O. The contribution to g, due to the light source at Q when the direction of vision is along OP, is given by

$$\frac{4 \cdot 16}{B} \frac{E}{\theta^{1 \cdot 5}}$$

where $E = \frac{I_P}{d^2} \cos\theta$, θ = POQ, and I_P is the candle-power of the lamp in the direction of OQ. The average of this contribution over all directions of vision within α degree of OQ is given by

$$T = \frac{1}{\pi R^2} \int_0^R \frac{4 \cdot 16 I_P}{Bd^2} \frac{\cos\theta}{\theta^{1 \cdot 5}} 2\pi r\, dr$$

where $\frac{R}{d} = \frac{\alpha}{57 \cdot 3}$, or approx. $T = \frac{4 \cdot 4 \cdot 16}{\alpha^{1 \cdot 5}} \cdot \frac{I_P}{Bd^2}$

I_P will have different values for the respective distant lamps. It will be a tolerable approximation to put in every case $I_P = I_H$, where I_H is the average candle-power of the fitting in the range o to α degrees from the horizontal.

We shall suppose it legitimate to treat all lamps after the first in this way. We shall further suppose that the position in the span at which the effects of the other lamps are determined is the position at which the glare effect due to the first lamp is a maximum. Let this position be x feet away from the nearest lamp, the span distance being s feet. Clearly x is equal to $\frac{h}{\tan\theta_m}$ where θ_m has been determined above. The average contributions to g due to the second, third and fourth lamps, etc., will then be given by

$$T_2 = \frac{4 \cdot 4 \cdot 16\, I_H}{B\, \alpha^{1 \cdot 5}} \frac{1}{(x+s)^2}$$

$$T_3 = \frac{4 \cdot 4{\cdot}16\ I_H}{B\ \alpha^{1{\cdot}5}} \qquad \frac{1}{(x+2s)^2}$$

$$T_4 = \frac{4 \cdot 4{\cdot}16\ I_H}{B\ \alpha^{1{\cdot}5}} \qquad \frac{1}{(x+3s)^2}, \text{ etc.}$$

The total contribution of the distant lamps T_D is then given by

$$\frac{4 \cdot 4{\cdot}16\ I_H}{B\ \alpha^{1{\cdot}5}} \left\{ \frac{1}{(x+s)^2} + \frac{1}{(x+2s)^2} \quad . \quad . \quad . \quad . \right\}$$

$$= \frac{4 \cdot 4{\cdot}16}{B\alpha^{1{\cdot}5}} \cdot \frac{I_H}{s^2} \cdot Z^1$$

The factor Z^1 depends on the value of x/s. For $x = \alpha$ it equals $\frac{1}{6}\pi^2$; for $x = s$ it equals $\frac{1}{6}\pi^2 - 1$. Thus the problem of evaluating the glare effects of the more distant lamps is reduced to the choice of a suitable value of α

General considerations of conditions of vision in streets indicate that α should be of the order of 10°. To test this suggestion use was made of data obtained in the Sheffield street-lighting investigation. For the different installations, the contribution of the distant lamps, T_D, was computed by the method here given, taking α as 10°. T_D had previously been computed (in the "Sheffield" paper) by a direct method, taking into account the exact position in the field of view occupied by each lamp in the different installations. On the average, for the ten installations concerned, the ratio of T_D, by the direct method, to T_D by the present method involving α, equalled 0.65. If α had been chosen equal to 13° this ratio would have equalled unity. Thus $\alpha = 10°$ is of the right order, although the most suitable value is perhaps rather larger. Further experimental work would be required before α could be fixed with reasonable certainty. Meanwhile it will be assumed that $\alpha = 10°$ in the rest of the paper.

TABLE I

Values of $A = \dfrac{\sin^2\theta\cos\theta}{\theta^{1{\cdot}5}}$

θ (in degrees)		A	θ (in degrees)		A
0	..	0×10^{-3}	45	..	$1{\cdot}17 \times 10^{-3}$
5	..	$0{\cdot}71 \times 10^{-3}$	50	..	$1{\cdot}06 \times 10^{-3}$
10	..	$0{\cdot}93 \times 10^{-3}$	55	..	$0{\cdot}94 \times 10^{-3}$
15	..	$1{\cdot}11 \times 10^{-3}$	60	..	$0{\cdot}81 \times 10^{-3}$
20	..	$1{\cdot}23 \times 10^{-3}$	65	..	$0{\cdot}66 \times 10^{-3}$
25	..	$1{\cdot}30 \times 10^{-3}$	70	..	$0{\cdot}52 \times 10^{-3}$
30	..	$1{\cdot}32 \times 10^{-3}$	75	..	$0{\cdot}37 \times 10^{-3}$
35	..	$1{\cdot}30 \times 10^{-3}$	80	..	$0{\cdot}24 \times 10^{-3}$
40	..	$1{\cdot}23 \times 10^{-3}$	85	..	$0{\cdot}11 \times 10^{-3}$
45	..	$1{\cdot}17 \times 10^{-3}$	90	..	0

In accordance with the suggestion made above, the glare figure of the installation as a whole is defined to be

G = 1 + maximum glare contribution of first lamp
+ average total glare contribution from the remaining lamps,

$$\text{or } G = 1 + \frac{4{\cdot}16}{B}\left\{\frac{(I_\theta A)_m}{(h-5)^2} + \frac{I_H}{s^2}\ Z\right\};\ Z = \frac{4}{\alpha^{1{\cdot}5}} \cdot Z^1$$

for a central suspension system,

$$G = 1 + \frac{4{\cdot}16}{B}\left\{\frac{(I_\theta A)_m\lambda}{(h-5)^2} + \frac{I_H}{s^2}\ Z\right\}$$

for a staggered or single side system.

Possibly the most elusive magnitude to be determined in connection with the glare figure is the general level of brightness in the street B. The general assumption underlying most methods of obtaining B is that the average horizontal illumination is proportional to the average brightness. This would hold strictly only for a perfectly diffusing road surface, which is never met with in practice. At the present time, however, it appears impossible to proceed with any other assumption than that given. For computing average illumination there are, of course, many more or less complicated methods. A simple method, giving an approximate result, is contained in Appendix II, but it may be felt that a more precise calculation is necessary. Having found the average illumination $\overline{H}$, the average brightness is then obtained by assuming a diffuse reflection of 10 per cent. It is obvious that $B = \frac{0{\cdot}1}{\pi}\overline{H}$.

4.—Procedure for Computing the Glare Figure of an Installation.

The data required are the following:—

(*a*) The complete polar curve of the fitting.
(*b*) The mounting height, *h*.
(*c*) The length of the span, *s*.
(*d*) The width of the carriage way, *w*.

Using the polar curve of the fitting and the values of A given in Table I, θ_m is obtained by the method described above, $(I_\theta A)_m$ being obtained in the process. Knowing θ_m, Z and, if necessary, λ are read off from Tables II and IV. I_H, the average candle-power in the range from 0° to 10° below the horizontal, is readily calculated from the polar curve. Finally, the average horizontal illumination H is obtained by the method given in Appendix II or otherwise. The glare figure follows immediately by substituting in the equation

$$G = 1 + \frac{4{\cdot}16\,\pi}{0{\cdot}1\,.\,H}\left\{\frac{(I_\theta\ A)_m\ \lambda}{(h-5)^2} + \frac{I_H}{s^2}\ Z\right\}$$

$$\text{or } G = 1 + \frac{131}{H}\left\{\frac{(I_\theta\ A)_m\ \lambda}{(h-5)^2} + \frac{I_H\ .\ Z}{s^2}\right\}$$

(For centre-suspension systems $\lambda = 1$).

The method for finding G can be applied to asymmetric fittings if the polar curve is taken for the plane in which the candle-power reaches its maximum value, and the average illumination is derived by a method applicable to asymmetric fittings.

TABLE II

Values of Z.

$\frac{h}{s}\cot\theta m$		Z	$\frac{h}{s}\cot\theta m$		Z
0	..	0·207	0·5	..	0·116
·1	..	0·178	0·6	..	0·106
·2	..	0·157	0·7	..	0·099
·3	..	0·140	0·8	..	0·093
·4	..	0·127	0·9	..	0·087
·5	..	0·116	1·0	..	0·081

5.—Numerical Values of the Glare Figure.

In Table III are shown the results of a lengthy series of calculations of the glare figure for a group of installations covering most types used in practice. The order of the installations in the table is that of increasing average horizontal illumination H for the central suspension system.

The glare figures G are given in columns 9 and 13. For each installation there are two G values, depending on whether the fittings are mounted in the centre line of the street or placed on the curb (staggered and single side systems give the same G value). In the present method, as previously stated, the glare effect of the first lamp is not the same for staggered and centre systems, although the glare effects of the distant lamps are taken as identical for the two cases. Furthermore, the average brightness of the road surface is less for the staggered than for the centre system. However, in almost every case the final glare figure G is greater for the centre than for the staggered system, the average value of the ratio of the two values of G, $\dfrac{\text{G staggered}}{\text{G centre}}$, for this set of installations equalling 1.32.

This result illustrates, from the glare standpoint, the accepted conclusion that the staggered system is preferable to the centre system. In the glare clause of the B.E.S.A. Specification centre and staggered systems are not differentiated.

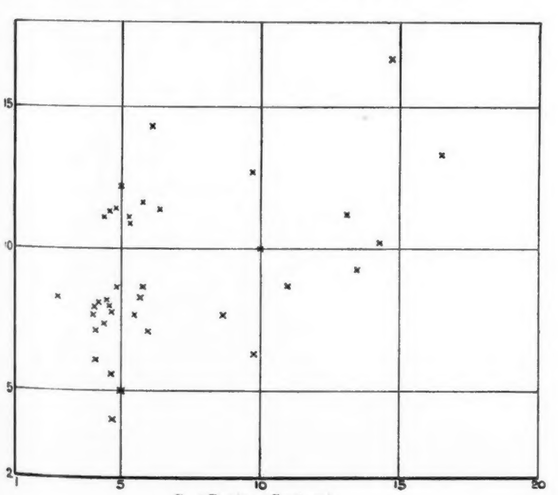
The second point to be considered is the relative contributions to the glare figure due to the first lamp and to the remaining lamps. The ratio $\dfrac{T_D}{T_1}$ gives a suitable indication of the relation. The average value of T_D/T_1 for centre systems comes out to be 0.67, i.e., the contribution of the remaining lamps equals 67 per cent. of that of the first lamp. For the staggered systems the average T_D/T_1 equals 2.1, and in this case the distant lamps are relatively more important. This is due to the fact that the glare contribution from the first lamp is always less for the staggered system.

TABLE III

No. of Inst.	Description of Fitting	h ft.	s ft.	w ft.	Centre Suspension System H	Centre Suspension System $\frac{T_1}{B}$	Centre Suspension System $\frac{T_D}{B}$	Centre Suspension System G	Staggered or Single Side System H	Staggered or Single Side System $\frac{T_1\lambda}{B}$	Staggered or Single Side System $\frac{T_D}{B}$	Staggered or Single Side System G	B.E.S.A. Specification Class*	B.E.S.A. Specification Glare Figure Gs
1	Directional Axial Asymmetric I—200watts	23	166	30	0·092	0·017	0·009	9·8	0·080	0·011	0·009	9·0	F	6·3
2	Do. do. do.	18	194	24	0·100	0·032	0·008	13·5	0·087	0·020	0·008	11·0	G	9·3
3	Directional Symmetric I —200 watts . .	15	120	30	0·166	0·039	0·015	11·0	0·137	0·014	0·015	7·5	F	8·7
4	Directional Axial Asymmetric II—200 watts	18	216	30	0·185	0·060	0·019	14·3	0·167	0·030	0·019	10·1	F	10·2
5	Directional Symmetric I—500 watts . .	22	146	37	0·200	0·033	0·016	8·7	0·168	0·017	0·016	7·2	E	7·7
6	Directional Symmetric II—300 watts. .	20	164	24	0·240	0·025	0·011	5·7	0·210	0·016	0·011	5·0	G	8·3
7	Directional Axial Asymmetric II—200 watts	15	180	30	0·261	0·101	0·028	16·5	0·233	0·036	0·028	9·6	F	13·3
8	Directional Symmetric I—500 watts . .	18	144	37	0·287	0·057	0·025	10·0	0·236	0·022	0·025	7·3	E	10·0
9	Directional Symmetric II—400 watts . .	21	160	30	0·292	0·023	0·023	6·0	0·244	0·013	0·023	5·6	F	7·1
10	3-light gas	14	102	24	0·302	0·017	0·015	4·4	0·232	0·005	0·015	3·8	G	7·4
11	Directional Axial Asymmetric II—500 watts	22	264	37	0·309	0·087	0·031	13·1	0·279	0·045	0·031	9·6	F	11·2
12	Directional Symmetric II—450 watts. .	19	144	37	0·404	0·032	0·025	5·5	0·321	0·013	0·025	4·8	E	7·7
13	Directional Symmetric III—300 watts. .	13	140	24	0·405	0·053	0·003	5·3	0·245	0·018	0·003	3·6	G	10·9
14	Directional Symmetric II—450 watts. .	24	110	46	0·420	0·018	0·036	5·0	0·334	0·008	0·036	5·1	D	5·0
15	10-light gas	22	139	34	0·424	0·017	0·024	4·1	0·330	0·008	0·024	4·1	E–F	6·1
16	Directional Symmetric III—500 watts. .	16	170	30	0·448	0·061	0·007	5·8	0·335	0·023	0·007	3·8	F	8·7
17	Directional Axial Asymmetric II—500 watts	18	216	37	0·451	0·149	0·047	14·7	0·403	0·058	0·047	9·2	F	16·7
18	6-light gas	14	135	24	0·472	0·038	0·019	4·8	0·372	0·006	0·019	3·0	G	11·4
19	Directional Symmetric III—300 watts	10	107	30	0·522	0·135	0·006	9·5	0·217	0·016	0·006	4·1	F*	12·7
20	10-light gas	15	150	30	0·536	0·049	0·024	5·3	0·389	0·014	0·024	4·0	F	11·1
21	Directional Symmetric III—500 watts. .	18	99	46	0·614	0·044	0·016	4·1	0·430	0·010	0·016	2·9	D	7·1
22	Directional Symmetric III—1000 watts	25	150	46	0·712	0·048	0·022	4·0	0·534	0·023	0·022	2·4	D	7·7
23	Directional Symmetric III—500 watts. .	16	88	46	0·739	0·061	0·021	4·5	0·508	0·007	0·021	2·8	D*	8·3
24	Directional Symmetric III—1000 watts	18	190	37	0·754	0·113	0·017	6·4	0·562	0·041	0·017	4·2	E	11·4
25	Directional Symmetric III—1500 watts	21	227	37	0·847	0·112	0·018	5·8	0·652	0·053	0·018	4·4	E	11·6
26	Directional Symmetric III—1000 watts	21	126	54	0·902	0·075	0·032	4·7	0·643	0·019	0·032	3·6	C	7·8
27	2-light high-pressure gas	26	108	54	0·922	0·024	0·085	4·7	0·716	0·008	0·085	5·0	C	4·0
28	Directional Symmetric III—1000 watts	21	126	46	0·956	0·075	0·032	4·6	0·704	0·027	0·032	3·7	D	8·0
29	2-light high-pressure gas	21	125	46	0·972	0·041	0·075	4·7	0·751	0·012	0·075	4·6	D	5·6
30	Directional Symmetric III—1500 watts	21	138	54	1·100	0·072	0·038	4·1	0·814	0·027	0·038	3·5	C	8·0
31	Arc	25	180	46	1·18	0·066	0·070	4·6	0·924	0·026	0·070	4·3	D	11·3
32	Directional Symmetric III—1500 watts	21	116	65	1·36	0·112	0·055	4·9	0·946	0·013	0·055	3·3	B*	8·7
33	Directional Symmetric III—2000 watts	25	120	65	1·58	0·096	0·063	4·2	1·13	0·028	0·063	3·5	B	8·1
34	Directional Symmetric III—3000 watts	21	227	46	1·59	0·225	0·035	6·1	1·17	0·079	0·035	4·1	D	14·3
35	Directional Symmetric III—3000 watts	30	135	65	1·88	0·092	0·071	3·7	1·39	0·037	0·071	3·5	B	8·3
36	Directional Symmetric III—3000 watts	25	113	80	2·30	0·144	0·104	4·4	1·60	0·017	0·104	3·4	A*	11·1

* Installations are classed by means of the minimum horizontal illumination. An installation in which the mounting height does not come up to the standard laid down in the specification is marked with an asterisk.

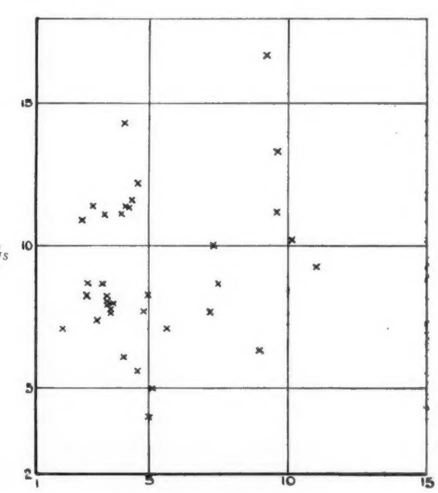
In order to compare the glare figure computed by the new method with that found using the specification method (denoted by G_s), two diagrams have been prepared in which G is plotted against G_s, (1) for centre systems, (2) for staggered systems (Figs. 2 and 3). With respect to these figures it should be noted that the true zero for G, i.e., the value of G corresponding to total absence of glare, is $G = 1$. For G_s the value corresponding to no glare varies with the general level of



G (Centre System).

FIG. 2.

brightness in the street, i.e., with the class of street. Under the best conditions, G_s cannot fall below about 2. A consideration of Figs. 1 and 3 shows that there is only a very weak correlation between G and G_s. One principal cause of this is the fact that in computing G_s the effects of lamps other than the first are entirely omitted. It is interesting now to see the connection between G_s and the glare figure computed by the new method, but omitting the contribution of the distant lamps, i.e., the connection between G_s and $(G - T_D)$. The Figs. 4 and 5 give the appropriate data in graphical form. Although the correlation between G_s and $(G - T_D)$

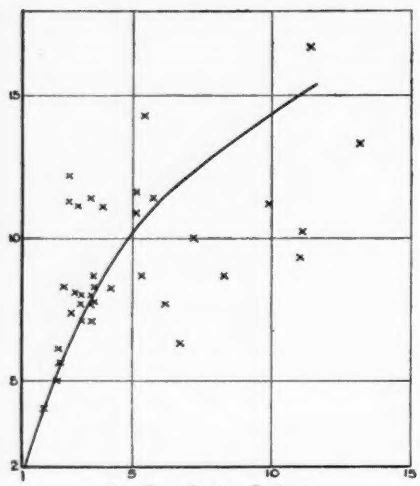


G (Staggered System).

FIG. 3.

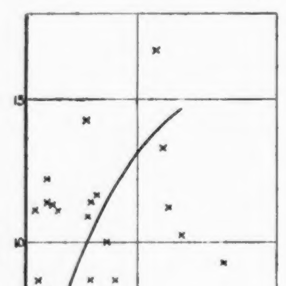
is a little better than between G_s and G, it is still very weak. Thus the new method differs from the old in another respect, besides the allowance made for the distant lamps. It will be instructive to explain in some detail how this second cause of difference arises.

In both methods the absolute magnitude of the glare effect due to the first lamp is determined principally by the candle-power of the fitting in the direction at which the glare effect of the fitting is a maximum. In arriving at a glare figure, however, account is taken of



G — T$_D$ (Centre System).
FIG. 4.

the fact that in a brightly illuminated street the seriousness of a given absolute glare effect is less than in a poorly illuminated street. Now it is in making this allowance that the two methods differ. The method of



G — T$_D$ (Staggered System).
FIG. 5.

the B.E.S.A. Specification uses the classification in terms of the minimum horizontal illumination, in order to correct for the different brightness levels in different installations. But the minimum horizontal illumination is, in most cases, determined by the candle-power of the fitting at or near the direction for which the glare effect is a maximum. This method in effect takes no account of the light distribution by the fitting in other directions in allowing for the general level of brightness in the street. In the new method the allowance for brightness level is based on the average illumination of the road surface, which will depend on the complete polar curve of the fitting. The method of the specification will tend to give the same glare figure for an installation in which the lighting fitting is highly directional, with the peak candles pointing at the test point, as it gives for an installation in which the fitting is practically non-directional, but produces the same test-point illumination. In the new method the non-directional installation will be given a lower glare figure than that for the directional fitting, because of the higher *average* illumination it will produce on the road surface. It must be remembered, of course, that the non-directional fitting will in general require a lamp of higher wattage to produce the same test-point illumination, and, furthermore, the illumination will not be so uniform as for the directional fitting.

TABLE IV

VALUES OF THE CORRECTION FACTOR λ.

$\downarrow X = \frac{w}{2(h-5)}$ \ θ →	0°	5°	10°	15°	20°	25°	30°	35°	40°
0·0	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00	1·00
0·1	0·973	0·972	0·970	0·969	0·968	0·967	0·965	0·963	0·957
0·2	0·946	0·943	0·940	0·938	0·937	0·934	0·930	0·925	0·914
0·3	0·919	0·914	0·909	0·907	0·905	0·901	0·895	0·887	0·871
0·4	0·892	0·885	0·878	0·875	0·873	0·867	0·860	0·849	0·827
0·5	0·842	0·837	0·831	0·825	0·817	0·805	0·790	0·767	0·735
0·6	0·791	0·789	0·784	0·775	0·761	0·743	0·720	0·685	0·643
0·7	0·740	0·740	0·737	0·725	0·706	0·680	0·650	0·602	0·550
0·8	0·693	0·693	0·689	0 673	0·652	0·622	0·586	0·527	0·454
0·9	0·646	0·647	0·641	0·621	0·598	0·564	0·522	0·452	0·358
1·0	0·600	0·598	0·592	0·570	0·545	0·507	0·459	0·376	0·262
1·1	0·555	0·551	0·543	0·522	0·495	0·453	0·397	0·303	—
1·2	0·510	0·504	0·494	0·474	0·445	0·399	0·335	0·230	—
1·3	0·465	0·458	0·444	0·425	0·394	0·346	0·273	0·157	—
1·4	0·432	0·424	0·410	0·393	0·357	0·304	0·218	—	—
1·5	0·399	0·390	0·375	0·361	0·320	0·262	0·163	—	—
1·6	0·367	0·357	0·340	0·328	0·284	0·220	0·108	—	—
1·7	0·348	0·339	0·324	0·306	0·258	0·180	—	—	—
1·8	0·329	0·320	0·307	0·284	0·232	0·140	—	—	—
1·9	0·310	0·302	0·291	0·262	0·206	0·100	—	—	—
2·0	0·292	0·283	0·274	0·240	0·180	0·060	—	—	—
2·1	0·279	0·270	0·259	0·222	0·157	—	—	—	—
2·2	0·265	0·256	0·243	0·204	0·133	—	—	—	—
2·3	0·252	0·243	0·228	0·186	0·111	—	—	—	—
2·4	0·238	0·229	0·212	0·161	0·088	—	—	—	—
2·5	0·225	0·215	0·196	0·149	0·063	—	—	—	—

(To be continued.)

The Public Works, Roads and Transport Congress Exhibition

Paper to be presented by A. P. L. E.

THE sixth Public Works, Roads and Transport Exhibition will be held at the Royal Agricultural Hall, London, during November, 16th–21st. As usual the range of topics discussed is very wide. It is proposed, however, that a general paper should be presented on behalf of the Association of Public Lighting Engineers reviewing aspects of street lighting of importance in connection with traffic. It is intended to make this a composite paper, containing items of information and ideas presented by various members (to whose services due acknowledgment will be made). The Hon. Secretary (Mr. J. S. Dow, 32, Victoria Street, London, S.W.1) would be glad to hear from any member who has items of information which he desires to have mentioned, or suggestions for future investigations. The following topics have already been suggested for treatment. This list is, of course, in no way exhaustive, but its publication may serve to show the kind of information that is desired.

(1) *Street Lighting in regard to Traffic.* Information on methods of lighting (e.g., central suspension of lamps) found effective in special cases; methods of lighting adopted at junctions of very busy roads, etc.

(2) *Relation between Street Lighting and Safety.* Information on proportion of accidents occurring by night and by day; statistics enabling influence of lighting on number of accidents to be traced; suggested methods of locating dangerous spots where better lighting is needed, etc.

(3) *Lighting of Arterial Roads.* Methods of finance and special systems of lighting preferred.

(4) *Illuminated Notices and Signs* (e.g., use of illuminated notices to indicate loop-ways, illuminated direction and Safety signs, signs to show crossings for pedestrians, etc.).

(5) *Automatic Light Signals.* Precautions desirable in regard to design or position; instances of their value in diminishing accidents or facilitating flow of traffic, etc.

(6) *Motor-car Headlights.* Possibility of establishing a standard of public lighting rendering headlights unnecessary; methods of use on arterial roads, etc.

(7) *General Principles of Administration of Public Lighting* (e.g., desirability of central control or combined action, as in the case of arterial roads traversing areas controlled by numerous small local authorities, etc.).

Literature on Lighting

(Abstracts of recent articles on Illumination and Photometry in the Technical Press)

(*Continued from page* 140, *June*, 1931)

Abstracts are classified under the following headings: I, Radiation and General Physics; II, Photometry; III, Sources of Light; IV, Lighting Equipment; V, Applications of Light; VI, Miscellaneous. The following, whose initials appear under the items for which they were responsible, have already assisted in the compilation of abstracts: Miss E. S. Barclay Smith, Mr. W. Barnett, Mr. S. S. Beggs, Mr. F. J. C. Brookes, Mr. H. Buckley, Mr. H. M. Cotteril, Mr. J. S. Dow, Dr. S. English, Dr. T. H. Harrison, Mr. C. A. Morton, Mr. G. S. Robinson, Mr. W. C. M. Whittle and Mr. G. H. Wilson. Abstracts cover the month preceding the date of publication. When desired by readers we will gladly endeavour to obtain copies of journals containing any articles abstracted and will supply them at cost.—Ed.

I.—RADIATION AND GENERAL PHYSICS.

100. The Characteristic Surface i = f (F.V) of a Gas-filled Photo-electric Cell. G. A. Boutry.

Comptes Rendus, 192, *pp*. 411-413, *February 16th*, 1931.

The variation of current *i* with luminous flux *F* falling on the cell, and applied voltage V is given. The curves are divided into five regions of different properties, and the physical explanation of the different phenomena stated. S. S. B.

II.—PHOTOMETRY.

101. Photocells and the Measurement of Light. L. Bloch.

Licht u. Lampe, 20, *pp*. 179-184, *May 28th*, 1931.

Compares the sensitivity of alkali cells with and without amplifiers with a new copper-oxide cell. Approximately 100 microamperes per lumen can be obtained from the latter. Curves showing the relation between illumination and cell current and the colour sensitivity are given. The uses of the cell for all the normal photometric and radiation measurements are discussed. G. H. W.

102. On a Photo-electric Apparatus for the Measurement of Reflection, Transmission and Absorption. P. Selenyi.

Licht u. Lampe, 20, *pp*. 147-8, *April 30th*, 1931.

Describes a photo-electric apparatus for these measurements and gives the results of tests on various materials. G. H. W.

103. Photometric Properties of Uneven Diffusing Surfaces. J. Dourgnon and P. Waguet.

Comptes Rendus, 192, *pp*. 406-408, *February 16th*, 1931.

A mathematical treatment of the effect of reflection of light from one part of an uneven diffusing surface to another is given, and factors are obtained enabling the effect to be estimated. Results of experiments, using a small hemispherical hollow in a set of plaster plates of varying reflection factor, are presented. These show good agreement with the theory. An equation is suggested for the general case of a stippled surface.

III.—SOURCES OF LIGHT.

104. The Actual State of our Knowledge of the Low-pressure Mercury Arc. M. Leblanc and M. Demontvignier.

R.G.E., *pp*. 891-904, *June 6th*, 1931.

Discusses the nature and properties of the arc and derives the fundamental equations for the positive column, introducing the theory of Tonks and Langmuir. Methods for exploring the discharges by means of "sounding" electrodes, both for direct and alternating currents, are given. (To be continued.) W. C. M. W.

IV.—LIGHTING EQUIPMENT.

105. Automatic Control of Lighting Installations. E. H. Vedder and S. G. Hibben.

Am. Illum. Eng. Soc. Trans., 26, *pp*. 517-523, *May*, 1931.

The photo-electric tube constitutes the foundation of automatic control units, which, with its accessories and typical assembly, is described briefly. Several actual and some suggested applications are mentioned that seem destined to widen the service to which artificial light may soon be put. Authors (G. H. W.).

106. How Much Light? Anon.

Brit. Jour. Phot., *Vol. LXXVIII*, *No*. 3,707, *pp*. 298-299, *May 22nd*, 1931.

Deals with a number of systems of photographic studio lighting and the effective use of portable electric lighting units in conjunction with daylight. F. J. C. B.

107. New Revolving Light Beacons. Anon.

El. Rev., 108, *p*. 933, *May 29th*, 1931.

A new type of revolving beacon having two 36 in. lenses is now being used in lighthouses, and has proved satisfactory for airway beacons. This gives 1,200,000 candle-power from a 1,000-watt lamp. It runs without attention, and the lamp is automatically changed in the event of a failure. G. S. R.

108. Artificial Sunshine for the Modern Office. Anon.

A.I.E.E. Journal, 50, *p*. 357, *May*, 1931.

This article describes an artificial sunshine unit for dual purposes. It will give 80 foot-candles direct "sunshine" on the desk surface, or an indirect general illumination of 10 foot-candles from eight 100-watt lamps. A special lamp equipped with a transformer supplies the "sunlight." G. S. R.

109. Portable Lights.

Brit. Jour. Phot., *Vol. LXXVIII*, *No*. 3,706, *pp*. 284-295, *May 15th*, 1931.

Describes a demonstration of portable lamps for photographic studio use held at the P.P.A. Congress, 1931. F. J. C. B.

110. Stage Lighting at the London Coliseum. Anon.

Elec., 106, *p*. 793, *May*, 1931.

Details are given of a new stage-lighting equipment at the London Coliseum. C. A. M.

111. On the Projection in Relief in Space of the Composite Image of the Autostereoscopic Picture. E. Esanavé.

Comptes Rendus, 192, *pp*. 1,367-1,368, *June 1st*, 1931.

By the use of a large plano-convex objective lens a stereoscopic effect can be obtained by direct vision of the picture, which carries a screen of vertical rulings. Animated pictures may be viewed by using horizontal rulings, and a combined stereoscopic and animated effect by using a square grating. S. S. B.

112. On an Ultra-Rapid Cinematograph, giving 2,000-3,000 Images per Second. E. Huguenard and A. Magnan.

Comptes Rendus, 192 *pp.* 1,370-1,373, *June 1st*, 1931.

Four small objectives are used in line, each covering a quarter of the width of normal film, giving images approximating 6 mm. by 5 mm. A special shutter operates each objective in turn, and with the film running at a speed of 3 m. per second, about 2,400 pictures can be recorded on this length of film. The speed can be increased to 5 m. per second (the normal speed for rapid cinematography, giving 250 pictures per second), and increasing the width of film to 60 mm. would then give 10,000 pictures per second. S. S. B.

V.—APPLICATIONS OF LIGHT.

113. The Lighting of Museums and Collections. F. Cellerier.

R.G.E., *pp.* 811-814, *May 23rd*, 1931.

After having indicated the principal conditions to be realized from the artistic point of view, in order to obtain a rational lighting for collections, the author shows the fundamental principles of this branch of lighting. The lighting of rooms and of the individual works of art is considered. Recommendations for illumination values are made. W. C. M. W.

114. Street Lighting Improvements. Anon.

El. Rev., 108, *p.* 867, *May 22nd*, 1931.

Presents photographs and a short description of the installation of all-enclosed asymmetric lanterns in High Street and Holland Park Avenue, Kensington. G. S. R.

115. Space and Lighting. H. Koch.

E. u. M. Licht, 8, *pp.* 13-20, *April*, 1931.

Deals with problems in modern architectural lighting and discusses the illumination and energy required for indirect schemes and lighting by diffusing glass. G. H. W.

116. New Landing Foodlights for Night Air Services. Anon.

E. u. M. Licht, 8, *pp.* 21-23, *April*, 1931.

Discusses the design of lens and reflector floodlights and describes a 3 kw. unit equipped with prismatic drum lens. The polar curve is given and shows a maximum intensity of 330,000 HK. G. H. W.

117. High-Intensity Lighting Systems for the Work World. M. Luckeish.

El. World, *Vol.* 97, *No.* 11, *p.* 510, *March 14th*, 1931.

In many cases high-intensity lighting is blamed for causing eye-strain, etc., whereas it is really the lighting system which is at fault. For indirect lighting a maximum of 30 to 50 foot-candles on the ceiling and upper walls is recommended when practicable. Indirect and properly controlled direct lighting may be used. The writer asserts that with a proper balance of direct and indirect units there is no practical limit to satisfactory foot-candle values. W. C. M. W.

118. The Theory of Linear Light Sources and Its Application to Illumination using Strip Lamps. E. L. J. Matthews.

Licht, *p.* 165, *March 15th*, 1931.

The light distribution from a range of strip lamps in line is considered theoretically and the results applied to the working out of a few practical problems. S. E.

119. Large Lamps for Modern Illumination. M. M. Samuels.

El. World, *Vol.* 97, *No.* 13 *pp.* 595-6, *March 28th*, 1931.

Owing to the progressiveness of architectural fitting designers there is now a demand for lamps of 60 to 200 watts having a filament 12 ins. long. No filament is suitable for this type of lamp. Hope is expressed that the gas discharge tube will meet this demand, but the possibility lies in the future. Modern architects are now making provision for lighting in designs of buildings. Entirely new ideas have to be developed by designers of lighting equipment. W. C. M. W.

120. Interim Report, Committee on Light in Architecture and Decoration. Anon.

Am. Illum. Eng. Soc. Trans., 26, *p.* 414, *May*, 1931.

Illustrations and descriptions of ten lighting schemes. G. H. W.

VI.—MISCELLANEOUS.

121. A Visibility Meter. M. G. Bennett.

Journal of Scientific Instruments, *Vol. VIII*, *No.* 4, *page* 122, *April*, 1931.

A meter is described which measures the degree of clearness with which any particular object can be seen. Very slightly ground glasses are introduced one by one into the field of vision. The number of these glasses, which is just sufficient to obscure the object observed, is the measure of its visibility. Various precautions are adopted, which obviate the sources of error found in other instruments of this type. Applications to meteorology and illuminating engineering are described. W. B.

122. Four Papers on Education in Illumination: "Educational Training in the Lighting Art." Preston S. Millar. "Illumination Options in Electrical Engineering Curricula." H. H. Higbie. "An Outline of a Course in Lighting for Architects." S. R. McCandless. "Illuminating Engineering in Home Economics Courses." Eloise Davison.

Am. Illum. Eng. Soc. Trans., 26, *pp.* 415-488. G. H. W.

123. Loss of Light due to Smoke in New York City. Anon.

Frank. Inst. J., 211, *pp.* 686-688, *May*, 1931.

Using a photo-electric cell and recording potentiometer, the U.S. Public Health Service recorded the daylight during the year 1927 at two points about nine miles apart, one in clear atmosphere and the other in an unusually smoky one. The loss due to smoke was found to depend on several factors, and some very interesting figures are given. S. S. B.

124. Psychological Methods of Making Determinations on Street and Traffic Lighting. C. G. Klein.

Licht u. Lampe, 20, *pp.* 163-166 *and pp.* 191-196.

Describes a new apparatus for the determination of seeing-power by means of measurements on glare effects, time for re-adaptation after glare, form perception, the influence of colour of light-sources and of objects. Detailed results of experiments are given and a street-lighting system can be analysed on a special form of diagram. G. H. W.

125. Colour Measurement. F. Ellrodt.

Licht u. Lampe, 20, *pp.* 148-150, *April 30th*, 1931.

Conclusion of article summarized in abstract. G. H. W.

POPULAR & TRADE SECTION

COMPRISING

**Installation Topics—Hygiene and Safety—
Data for Contractors—Hints to Consumers**

(The matter in this section does not form part of the official Transactions of the Illuminating Engineering Society and is based on outside contributions.)

Street Lighting from the Motorist's Standpoint

THE comments of the Motoring Correspondent of the *Evening News* are frequently shrewd and instructive, his views on street lighting, as expressed in a recent contribution, are worth study as illustrating the ideas of the motorist.

He remarks that the problem of dazzling headlights is a familiar one, and its various aspects have been discussed again and again. "Not nearly so much attention has been paid to the subject of road lighting and of illuminated or reflecting road signs. On a long run, especially in a traffic stream, we find the head-lamp problem less prominent, I think, than this other question. A glittering white sign looms up, an advertisement; a string of red lamps suddenly appears to block the whole width of the road—though it doesn't; a confusing splash of yellow light tells of a solitary street lamp at the entrance to a village.

"They all catch our eye; that is what they are meant to do. But can we say that they make night driving easier and safer?"

Turning to methods of street lighting he suggests that the time has come when the lamp-post is out of date. He refers in complimentary terms to the lighting of the Victoria Embankment, and compares it favourably with the lighting of other important thoroughfares. He also remarks how dangerous it is to illuminate a street refuge merely by a single lamp perched high above it. The newly floodlighted pillars, low down at either end of each refuge, are the greatest comfort. Lofty lamps in country districts, spaced far apart, tend to produce confusing splashes of light with darkness intervening. "For the motorist, in fact, the only sort of lighting that is of any advantage is floodlighting," though admittedly it is expensive and often difficult to arrange.

Finally, he urges that illuminated or reflecting signs should not be allowed at the roadside except to indicate dangers of the road. There should be no distracting advertisements and even petrol stations should keep their illuminations well back from the roads.

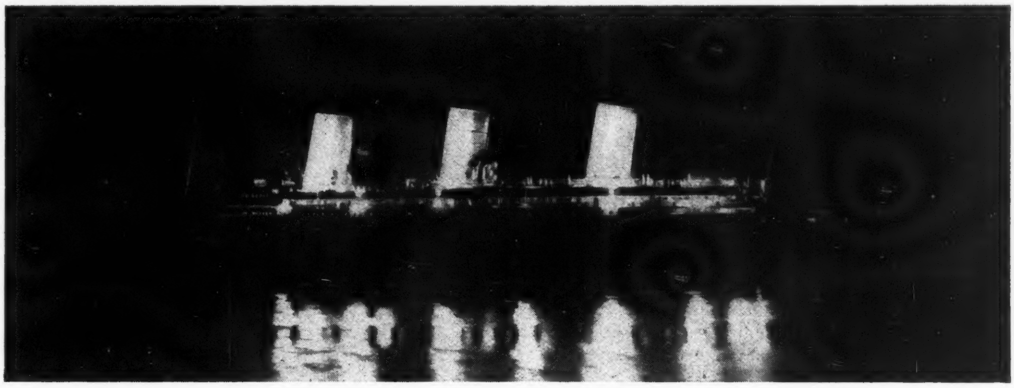


FIG. 1.—A striking night spectacle. The "Empress of Britain" with her floodlighted funnels.

Floodlighted Funnels on the "Empress of Britain"

The floodlighting of the funnels of the recently launched C.P.R. Steamer, "Empress of Britain," shown in Fig. 1 above, was carried out to the designs of the Illuminating Engineering Department of the General Electric Co. Ltd. The funnels tower some 68 ft. above the sun deck and the floodlights are located in readily accessible positions to bathe them with a sea of light. Four powerful units are employed per funnel, some being fitted with prismatic glass fronts to obtain an even spread of light. In order to obtain the maximum lighting efficiency, deep silver glass reflectors are used, the floodlights being totally enclosed in order to simplify cleaning, and obviating the necessity of frequently opening the units for interior cleaning purposes. Each unit is equipped with a 1,000-watt Osram lamp. The General Electric Co. Ltd. was responsible for the whole electric lamp equipment throughout the ship, some 22,000 Osram lamps being employed in the entire lighting scheme.

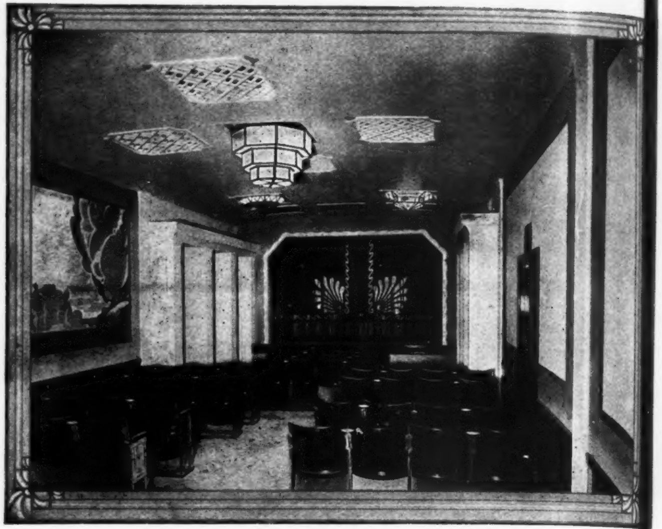
Powerful beams of light are directed evenly over the three funnels from all sides which, together with the general illumination, presents a striking spectacle by night.

The New Holophane Demonstration Theatre

A NUMBER of people well known in architectural, kinema and theatrical circles, amongst whom may be mentioned Mr. Alister MacDonald, the architect son of the Prime Minister, attended the opening of the new demonstration theatre constructed by Holophane Ltd. on June 17th.

Miss Muriel Angelus, the British film star, performed the opening ceremony and Mr. H. Hepworth Thompson, managing director, gave a short introductory address alluding to recent progress in colour-lighting and emphasizing the fact that the system exhibited was entirely of British origin. Mr. R. Gillespie Williams, chief colour consultant to Holophane Ltd., also made a few remarks referring to the important part played by colour in stage and cinema technique and subsequently explained each item on the programme as it appeared.

The display generally resembled those given in the old theatre, but a feature on this occasion was the introduction of a series of "turns," which served to illustrate how changing coloured light can enhance the graceful movements of dancers; specially effective was the series of striking colour changes created in the "Parade of Magic Kimonos." The "Moods of the Desert" once more served as a pleasing colour-interlude. The landscape transformation effected by alternate use of red and green light seems to have been improved, the disappearance of the first picture when the second takes its place being now very complete. The display was concluded by illustrations of how interior decoration can be altered by changing coloured light. It seemed to us that the colour changes of the silk stage curtain were even more striking than in the past and, in our opinion, this display, though simple, still forms one of the best of all.



A View of the new Holophane Demonstration Theatre, opened on June 17th.

The theatre is considerably more commodious than the original one, and serves very well to display decorative lighting, apart from scenic effects. The colour combinations in the Hedralite ceiling units were interesting and likewise the wall-fittings devised to throw splashes of coloured light on the wall in contrast to the luminous surface of the diffusing glassware.

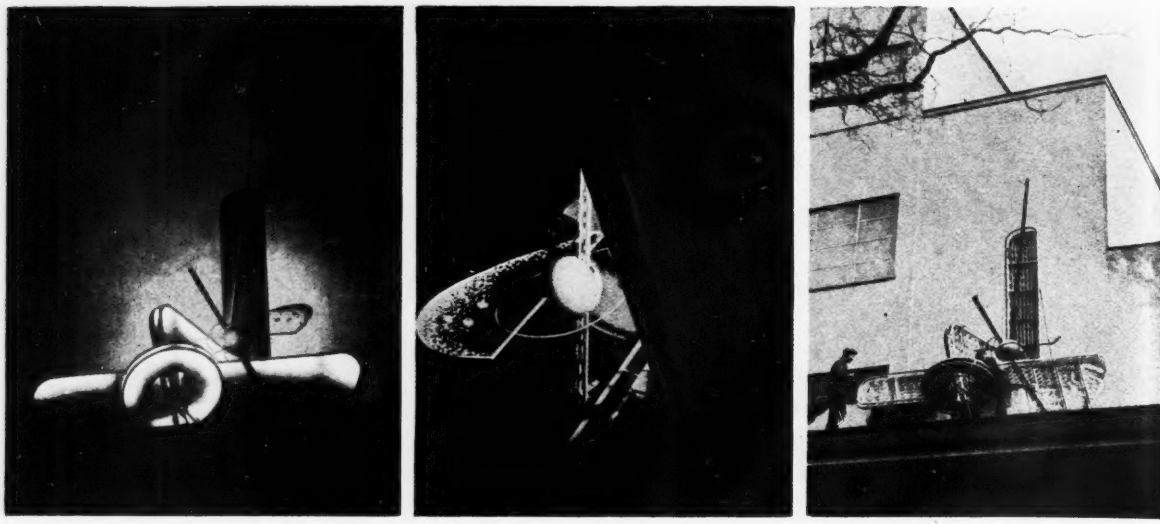
Steam Cleaning as an Aid to Illumination

It has been remarked that the grimy surfaces of buildings in most British cities is a great obstacle to the extension of floodlighting. Those interested in floodlighting have indeed every reason to support the smoke abatement movement. Lighting experts have also reason to bless the process of steam cleaning, not only as an aid to floodlighting, but an exceedingly valuable means of improving access of daylight. In many offices it is impossible to see any sky from the greater part of the room. Daylight is received entirely by reflection off adjacent buildings, and much depends on the nature of their surfaces.

At the moment we can see from our window a building some distance down the street which has recently been steam-cleaned. The contrast to adjacent untreated surfaces is amazing. If the process is continued to the high buildings immediately opposite, the daylight factor at the remote inner wall of the writer's office will probably be multiplied several times.

Personal

Mr. E. J. Shuter, who has been with the Illuminating Engineering Department of the General Electric Co. Ltd. since September, 1927, is leaving, on June 15th, to take up a position with the Claude-General Neon Lights Ltd.



Illustrating the novel structural embellishment illuminated at night and designed by Pesánek for the new Transformer Station of the Prague Electricity Works.

"Modelling in Light" in Prague

WE have received from Mr. Paul Grundfest, of Prague, an illustrated account of a novel and highly original form of "modelling in light" ("Lichtplastik") which is being developed in that city.

In October, 1930, the new transformer station of the City Electricity Works (the so-called Edison Station) was opened. On the frontage of this building, and at a height of six metres above the ground, there is a highly original piece of architectural embellishment which is illuminated at night. This is the work of Pesánek, one of the younger architects of Prague.

Pesánek's work has opened up a new conception of architectural treatment, different entirely from that of the past, and departing even from the very latest and most original ideas. He regards the future of structural art as being linked with the portrayal of motion ("Kinetismus"). Pesánek's name has already been made familiar to those interested in illumination by his invention, some years ago, of a remarkable colour-organ. Here electric light entered into structural art as an intimate element. Over one thousand colour glow lamps were controlled and regulated by electro-pneumatic means in this device. The mechanism permitted not merely the lighting up or extinguishing of lamps, but also, by the aid of rheostats, waxing and waning of the illumination. Any desired composition in lighting could be recorded by means of patterns of slots stamped out of paper, and could subsequently be "played" on this instrument in the same manner as an audible musical theme. The fact that Pesánek was specially invited to take part in the Colour Congress held in Hamburg in September, 1930, is of significance in showing the importance attached to this new departure.

In the figures above we are illustrating the novel lighting embellishment of the Edison Station. The bold horizontal lines symbolize the planes of the sea (the element "moll" or softness); the perpendicular lines, on the other hand, symbolize foliage of trees, the appeal of signs, etc. (the element "dur" or hardness), while the circles signify neutral elements. All such elements are depicted by the aid of forms characteristic of modern technical development; for example, parts of an aeroplane and an electrical lattice-mast, which also serve to carry the lighting equipment.

In contrast to luminous signs which, according to a shorter or longer rhythm, always return to the same conditions of brightness, we have here a lighting-composition capable of endless variation. The rhythm can be altered in any degree by means of the electro-pneumatic devices and rheostats, and symphonies in light and colour may be played. One can render composition of cold or warm colours with staccato, crescendo and diminuendo effects. By the courtesy of the Prague Electricity Works Mr. Grundfest has been able to illustrate this note by the accompanying pictures illustrating Pesánek's work. In this connection he quotes Pesánek's own words, to the effect that this "Lichtplastik" on the Edison Station is an effort towards a new form of artistic craft, mainly the use of light as a new motion-element. It will be interesting to observe to what goal Pesánek's further efforts will carry us. The next application of his theories will probably be found in the design of an international memorial to Aviators.

An Early Example of Floodlighting

Mr. G. Ellson, Chief Engineer of the Southern Railway, has drawn attention to a very early application of searchlights for the floodlighting of constructional work. When he was engaged in 1905 on the rebuilding of Charing Cross Station roof, it became necessary to build as rapidly as possible some large timber supports to the old roof adjacent to the portion that had been damaged. For the carrying on of this work, night and day, searchlights were set up and their beams trained on the part of the structure at which work was progressing. The searchlights were maintained by members of the Territorial section of the Royal Engineers (Electrical Engineers' Section), and this method of lighting was found to be most satisfactory. It seems probable that this may have been the first application in this country of "floodlighting" work of this description.

TRADE NOTES & ANNOUNCEMENTS

Architectural Lighting at the Trocadero

Members of the Illuminating Engineering Society will recall the interesting lighting at the Trocadero Restaurant, where the annual dinner of the Society was held last February. From a description which has now reached us it is evident that similar methods are adopted in other sections of the Trocadero, notably in the famous grillroom, which has been illuminated under the supervision of Mr. Oliver P. Bernard. A feature of the grillroom lighting is the series of suspended laylight-type ceiling fittings varying in length from eight to thirty feet, and consisting of internally ribbed white and pink glass tubes, secured together with fine silvered wire binding. No less than 45,000 glass tubes are used in these fittings, and there are about 90,000 soldered joints! In the Grill Room Extension three distinct types of lighting, luminous laylights, recessed cornices and demi-coupe brackets are used. Osram lamps are used throughout, and the General Electric Co. Ltd. was entrusted with the manufacture and supply of most of this special decorative lighting equipment.

Modern Church Lighting

This is the title of an illustrated leaflet issued by Callendar's Cable and Construction Co. Ltd. Not very much is said regarding lighting, though some hints on the choice of fittings are given. The leaflet deals primarily with the Callendar "Kalibond" wiring system, good features of which are its flexibility and unobtrusive appearance.

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Holophane Exhibits at the British Empire Trade Exhibition, Buenos Ayres, 1931

Much attention has been devoted in the Press to this Exhibition, which was regarded as illustrating the possibility of greatly increased British trade with the Argentine. Yet one is not conscious of having heard a great deal about British exhibits there. It is, therefore, of interest to put on record the enterprising effort of Holophane Ltd., whose stall is illustrated in Fig. 1. Besides a general display of typical prismatic glass units for scientific illumination, a feature was made of the newly developed "Pagoda" and "Hedralite" units. Holophane Ltd. were also awarded important contracts for the general lighting and floodlighting of various Exhibition buildings, a typical view (the Club) being illustrated in Fig. 2.

FIG. 1 – A View of the Holophane Stand.

FIG. 2.—Showing the Floodlighting of the Club.

CONTRACTS CLOSED.

Messrs. Siemens Electric Lamps & Supplies Ltd.: *Great Western Railway*—for twelve months' supply of Siemens gas-filled electric lamps.

REVIEWS OF BOOKS AND PUBLICATIONS RECEIVED

METHODS OF LIGHTING IN OLD JAPAN ("NIPPON KOTOKI TAIKAN"). (*Published by the Japanese Illuminating Engineering Society, Kansai Branch, 9 Naka 2-Chome Dojima, Kitaku, Osaka, Japan*).

We have received from the Japanese Illuminating Engineering Society a copy of the wonderful work bearing the above title, which has been prepared by Dr. Toru Motono, Past-President, with the aid of numerous assistants and advisers. Many other bodies have helped in the collection of this material, the Electrical Association for Japan and the Society for the Study of Japanese Customs may be mentioned. The original plan was to present about 300 typical photographs of lighting appliances, but in order to make the collection representative it was ultimately found necessary to include more than double this number.

The result is a remarkable collection of pictures of ancient Japanese lighting fittings excellently printed on fine matt paper and accompanied by descriptive matter in Japanese. An introduction, in English, explains the object of the production, and emphasizes the importance of studying ancient methods of lighting and fixture designs. In the case of such a country as Japan, with traditions of such wonderful artistic craft, study of this kind seems particularly desirable. Whilst one recognizes that the introduction of Western ideas on lighting and modern illuminants is inevitable one would like to see these new methods grafted on to the old in such a way that the charm of the ancient designs is not lost, and the national characteristics are preserved.

To lighting experts in this country these pictures are exceedingly interesting and they should, indeed, for their historic value make a wider appeal.

We understand that copies of the publication are still available and may be obtained from the Japanese Illuminating Engineering Society at the price of £2, plus 12s. to cover the cost of postage of this somewhat bulky volume.

THE EMPIRE MUNICIPAL DIRECTORY AND YEAR-BOOK, 1931-32. *The Sanitary Publishing Co. Ltd., London; pp.* 356; *price* 12*s.* 6*d. plus postage* 6*d.*

The above year-book is now in its 29th year of publication, so that next year should be an important milestone. It continues to meet an evident need and the records of local authorities and officials, occupying more than 150 pages, are unique. The Overseas section seems to have been extended recently, such distant spots as the Falkland Islands, Palestine, Seychelles, etc., being now included.

In Sections II to XVI numerous subjects of interest to municipal engineers are discussed. Amongst these may be mentioned Road Construction and Maintenance, Road Direction and Signal Signs; Plain and Reinforced Concrete and Cement; Lighting, Heating and Ventilation; Water Supply, Purification and Softening; Sewerage and Sewage Disposal; Fire Prevention; Housing and Town Planning, etc. In the Lighting, Heating and Ventilation Section there is a contribution reviewing progress in street lighting during the past year, a statement of "The Case for Electricity" and a survey of the progress of the Gas Industry under the name of Sir Francis Goodenough. Section II (Road Direction and Signal Signs) consists mainly of a summary of recent ministerial recommendations, and the names of some firms specializing in such signs are mentioned.

ELECTRICITY FOR EVERYBODY, *by W. Borelase Matthews* (*Electrical Press Ltd.; pp.* 469; +*lxxxvii;* 5*s. net*).

The fourth edition of this Electrical Compendium, which makes its appearance this year, has been remodelled and largely rewritten. The diary and calendar, etc., occupy nearly 100 pages and as mentioned above there are more than an additional 450 devoted to general information.

The book is planned in a methodical manner. Following the Diary and Calendar divisions are devoted to Electricity in the Home, Business, Public Buildings, Factories and Farms and Gardens. Each of these divisions is again subdivided into sections on lighting, cooking, water heating, heating and power. Each *section* is once more divided into *parts* dealing with advantage of electricity, cost, accomplishments, wiring, apparatus and special notes. The section devoted to lighting in the home contains useful hints, though we rather question whether the tabular data (coefficients of utilization, tables of mounting heights, etc.) can be very usually applied to domestic lighting. On the other hand one would imagine that standard data might be more welcome in the section on factories, where there are few tabular data beyond the table of lighting intensities. The author is an expert on the applications of electricity in farms and gardens and this section is very informative. We are interested to see a table giving the illumination necessary for bringing various plants into bloom. The precision with which these values are given is somewhat surprising. Can one really say with confidence that *Boltonia asteroides* (false starwort) requires exactly 268 foot-candles and *Erigeron canadensis* (horse weed) exactly 293?

In the final portion of the volume there is included a combined Directory of Electrical Contractors and a Gazeteer of Electrical Supplies—a feature which we understand will be developed in future annual editions.